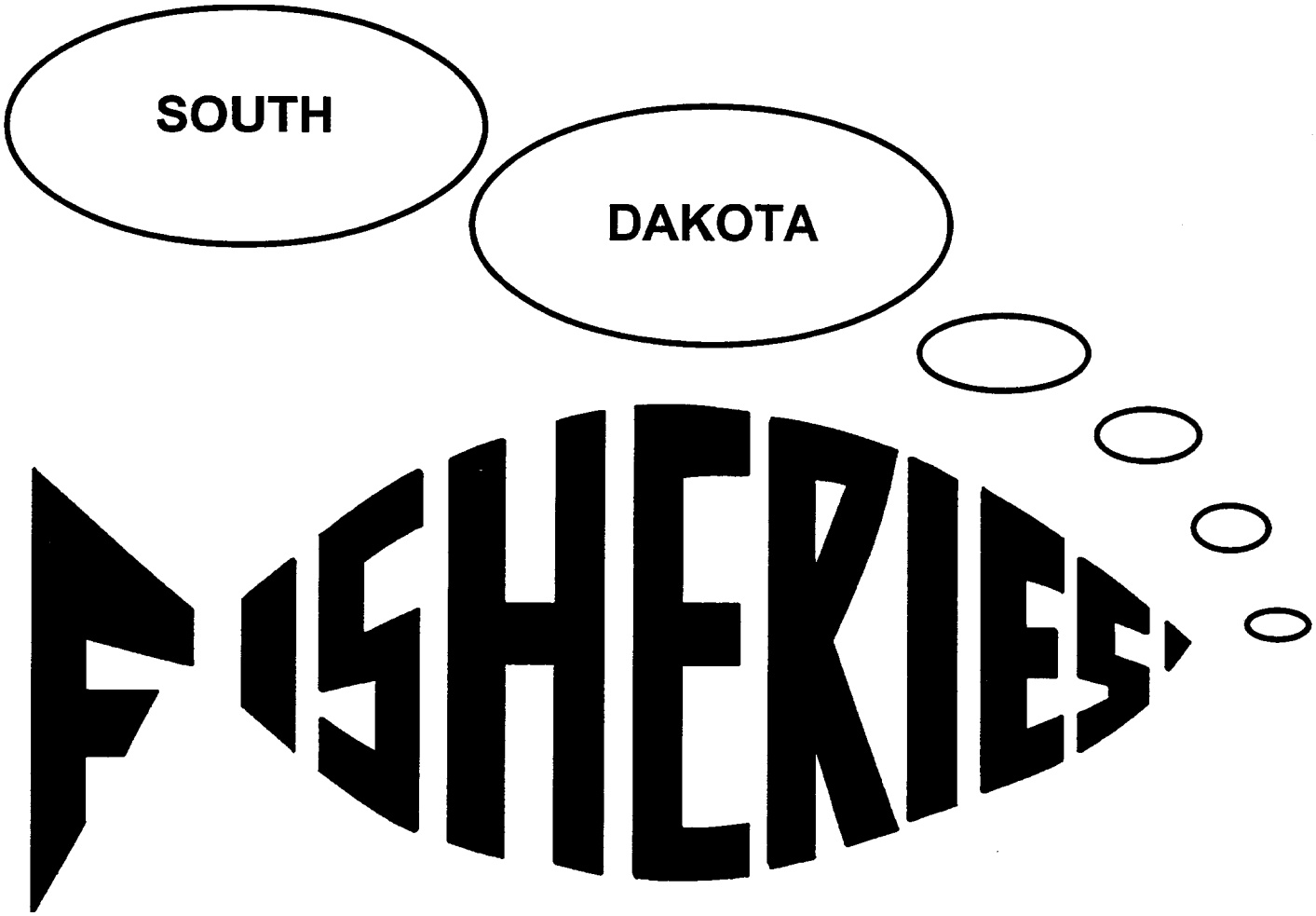


# Angler Use, Sport Fish Harvest, and Fish Community Surveys for Waubay Lake, Day County, SD December 1996 - August 2002

**South Dakota Department of Game, Fish and Parks**
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**Progress Report No. 03-06**

# Waubay Lake
# Fish Community Surveys 1997-2002
# Angler Use and Harvest Surveys December 1996-August 2002

by

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South Dakota Department of Game, Fish and Parks

Progress Report

Dingell-Johnson Project F-21-R-3.5

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## Preface

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The authors would like to acknowledge the many South Dakota Department of Game, Fish and Parks employees both permanent and seasonal that assisted with the collection of data, fish aging, and data entry: Todd Kaufman, Ryan Braun, Ron Meester, Don Riunpca, Jon Millim, Kyle Potter, Randy Mount, Cory Flor, Brook Brown, Josh Clayton, Chuck Pyle, Tara Collins, Martin Lang, Nate Olson, Kathryn McMillan, Scott Nilsson, Jennifer Harrington, Jason Jungwirth, Ryan Krapp, Cory Kassube, Preston Kilker, Heath Headley, Steve LeBay, and Janne Jockheck.

## Executive Summary

Increased water levels in the 1990's diminished the threat of winterkill at Waubay Lake allowing South Dakota Department of Game, Fish and Parks to initiate walleye stocking in 1994. Walleye stocking was successful with the formation of three consecutive year classes between 1994 and 1996. In addition to walleyes, northern pike, yellow perch, and black crappies have prospered in the expanded waters of Waubay Lake. This has resulted in Waubay Lake developing into a fishing destination for both South Dakota residents and nonresidents. Between December 1996 and August 2002 it was estimated that in excess of 18 million dollars were added to local economies as a result of the Waubay Lake fishery.

As the Waubay lake fishery began to flourish many of the anglers came from the immediate area, but as word spread concerning the fishing opportunities available at Waubay Lake, anglers that had traveled greater distances became common at Waubay Lake. From 1997 to 1999, over 75% of the anglers fishing Waubay Lake during open-water traveled less than 100 miles, one way, to fish Waubay Lake. The percentage of anglers traveling less than 100 miles decreased to approximately 50% between 2000 and 2002 and those traveling in excess of 200 miles increased to approximately 25% of all open-water anglers. The percentages of nonresident anglers fishing Waubay Lake increased between December 1996 and August 2002 for both open-water and ice-cover surveys. The greatest percent of nonresident anglers occurred during May through August 2002 when 40.5% of anglers fishing Waubay Lake were nonresidents. Most nonresident anglers are from Minnesota, Iowa, and North Dakota.

Walleye were the most sought species by open-water anglers and yellow perch were the dominant target species of anglers fishing through the ice. In 2001 and 2002, increased numbers of open-water anglers targeted yellow perch and black crappies than in previous years. Anglers commonly sought northern pike in 1997 and 1998, but interest in northern pike waned as angler interest in walleyes, yellow perch, and black crappies increased.

To date, walleye natural recruitment has been dismal. Stocking has been necessary to maintain walleye population abundance at levels that will provide a fishery. In 1999, an estimated 81,759 walleyes were harvested during May through August, angler catch rates exceeded 0.5 walleye per hour, and harvest exceeded 0.3 fish per hour. Following 1999, walleye harvest decreased, but catch rates increased. The increasing walleye catch rates were the result of successful stockings made in 1999. The 1999 walleye year class appears to be abundant and has experienced a growth slowdown, but the majority of the year class should exceed the minimum-length limit in 2003. Unfortunately, stocking completed in 2002 failed to create an additional year class. Thus, the walleye population is primarily composed of a single year class that will be available to anglers in 2003. In an effort to extend the 1999 year class until additional year classes can enter the fishery, the daily limit was reduced to two walleyes on January 1, 2003.

Yellow perch recruitment appears to have been consistent prior to 2000. The consistent recruitment during the mid to late 1990's led to the excellent yellow perch fishing experienced at Waubay Lake since 1998. During the winters of 1998-99 through 2001-02, yellow perch harvest exceeded 85,000 perch each winter with the peak occurring in 2001-02 when an estimated

148,062 perch were harvested. Yellow perch reproduction, when assessed by larval trawling and shoreline seining, was high during 2001. However, juvenile yellow perch were not prevalent in the 2002 gill net survey. It is likely that the abundant 1999 walleye year class substantially reduced the abundance of the 2001 yellow perch year class.

Northern pike likely were not sampled in their true abundance as gill- and frame-net catches tended to be low. Northern pike were common in the angler catch. Open-water anglers were less likely to harvest northern pike than were ice anglers.

Black crappies became a component of the angler creel in 1999 with a majority of black crappie harvest occurring during open-water periods. Interest in black crappies has increased with 15% of the open-water anglers targeting crappies in 2002. The black crappie population was primarily composed of adult fish until 2002 when juvenile crappies were present in the frame-net sample.

Anglers tended to be satisfied with their fishing experience at Waubay Lake and supported the various harvest regulations that have been enacted. Greater than 50% of interviewed anglers indicated that harvesting fish was somewhat to not important in determining their fishing success and approximately 10% indicated that it was very important to harvest fish to have a successful fishing trip. Relaxation was frequently referred to as an important factor in defining angler-trip success.

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Increased water levels of the 1990's diminished the threat of winterkill at Waubay Lake allowing South Dakota Department of Game, Fish and Parks (SDGFP) to initiate walleye stocking in 1994. The walleye fishery began attracting anglers in 1997. Additionally, northern pike, yellow perch, and black crappies have prospered in the high waters of Waubay Lake and have provided tremendous angling opportunities.

Because of the newly created angling opportunities, Waubay Lake has developed into a premier South Dakota fishing destination. Economic interests have benefited from the fishing recreation that Waubay Lake has provided. In recent years, angling pressure and fish harvest rates reached levels that were of concern to SDGFP biologists and Commission. In an effort to reduce walleye harvest a minimum length restriction of 16 inches (406 mm) with one walleye over 20 inches (508 mm) was enacted by the SDGFP Commission as an "Emergency Rule" in October 1998 and the regulation became law January 1, 1999. The SDGFP Commission as part of an "Emergency Rule" in October 2001 reduced yellow perch daily limit from 25 to 10 and the regulation became law for yellow perch, bluegill/sunfish, and crappies for waters in several northeast South Dakota counties on January 1, 2002. On January 1, 2003 the Waubay Lake walleye daily limit was decreased from four to two. The reduction to two fish was the result of several years of poor walleye recruitment.

Information concerning the Waubay Lake fish community and the angler use and harvest it supports is important in the ongoing fisheries management of the Waubay Lake fishery. This report summarizes fish community surveys completed from 1997 to 2002 and angler use and harvest surveys completed between December 1996 and August 2002.

## Study Site

Waubay Lake is a meandered lake located in Day County, South Dakota. Waubay Lake presently encompasses four previously distinct water bodies. These water bodies include - North Waubay, South Waubay, Spring Lake, and Hillebrands. Water levels in these four lakes rose dramatically through the 1990's resulting in a single water body - Waubay Lake. The period of 1993 through 1998 saw the water elevation rise from less than 1785 ft (544 m) above mean sea level (MSL) to elevations in excess of 1800 ft (548 m) above MSL from 1998 through 2002 (Figure 1).

Maximum depth of Waubay Lake exceeds 31 ft (9.5 m) and the surface area of Waubay Lake is 15,540 acres (6,294 ha) [North Waubay 9,668 acres (3,916 ha), South Waubay 3,173 acres (1,285 ha), Hillebrands 1,034 acres (419 ha), Spring Lake 1,665 acres (674 ha)]. Hillebrands and Spring Lake are contained within the boundaries of Waubay National Wildlife Refuge. No boating is allowed within the Refuge boundaries and fishing within the Refuge is only allowed during the winter months.

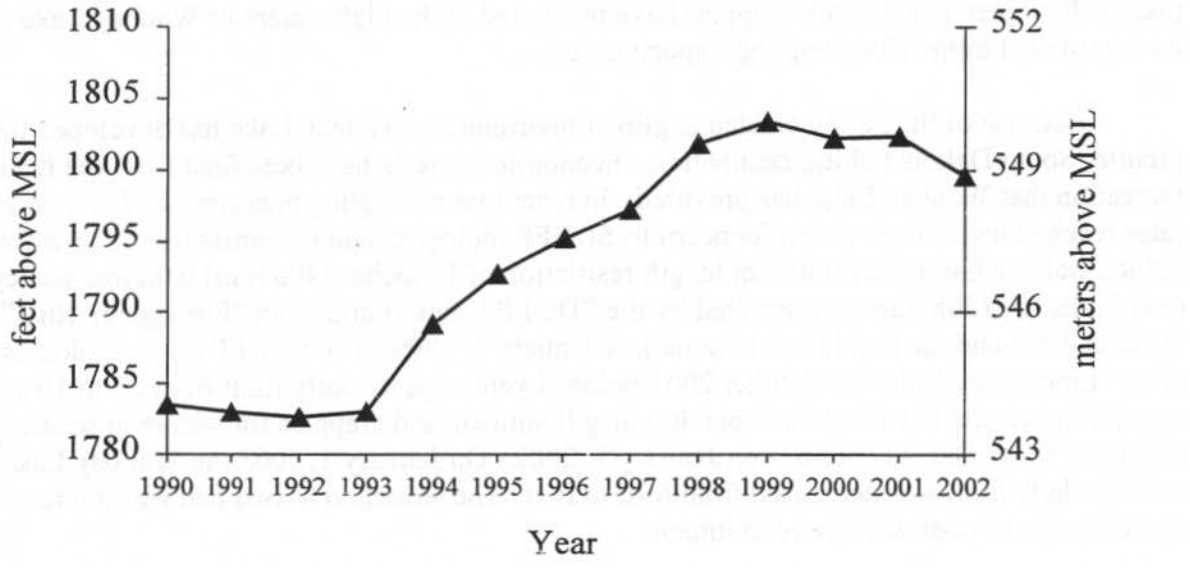


Figure 1. Approximate Waubay Lake water level elevations for 1990 to 2002. Water levels from 1990 to 1999 adapted from USGS Concepts Paper 10-12-99 and data for 2000 to 2002 provided by Dennis Skadsen (personal communication).

## Methods

Fish Sampling

The fish community was sampled with experimental gill nets (47.5 m X 1.8 m) and frame nets (double frame, 1.5 m x 1.3 m, mesh 19 mm) during August of each year (1997 - 2002). Gill nets were composed of six 7.6-m panels of varying mesh sizes arranged in a sequential fashion. Gill net mesh sizes were (bar measure) 13 mm (0.50 in), 19 mm (0.75 in), 25 mm (1.00 in), 32 mm (1.25 in), 38 mm (1.50 in), and 51 mm (2.00 in). Gill net effort was eight net nights during all years but 1997 when six net nights were used and frame net effort ranged from 23 to 32 net nights (Table 1). All nets were allowed to fish overnight and the total fishing time per net approximated 24 h. Collected fish were measured for total length (TL; mm) and weighed (g). Scale samples for age and growth analysis were removed from walleyes.

Nighttime electrofishing (DC-Pulse) was completed during each fall of 1998 - 2002 to assess age-0 walleye abundance (Table 2). In 1998, a Coffelt boat was used and a SmithRoot boat was used from 1999 to 2002. All walleyes less than 300 mm TL were netted. Total length (mm) and weight (g) were recorded for collected walleyes and scale samples removed to verify

age-0 TL range. Conductivity and water temperature were measured at the beginning of each electrofishing sample (YSI Model 30).

Recorded length and weight data were entered into WinFin Data Entry Program 3.42 (Francis 2001b). Scale samples were pressed onto acetate slides and viewed with a microfiche projector (42X). Scale annuli locations were recorded on paper strips and digitized on a computer screen using WinFin Data Entry Program 3.42 (Francis 2001b). Fish population parameters were computed using the WinFin Data Analysis Program 1.7 (Francis 2001 a). Parameters calculated included Proportional Stock Density (PSD) and Relative Stock Density (RSD; Willis et. al 1993) of various length groups. Minimum total lengths for the Gabelhouse (1984) length categorization system are provided in Table 3. Confidence intervals (90%) were calculated for PSD and RSD values. Electrofishing catch per unit effort (CPUE) was the number of age-0 walleyes caught per hour of electrofishing (foot-time only) and CPUE for gill nets and frame nets was the mean number per overnight net set for each gear. Standard errors of mean CPUE values were calculated. Relative weight (Wr) values were calculated using the standard weight (Ws) equations given in Blackwell et al. (2000). Mean Wr values were calculated per Gabelhouse (1984) length categories. Previous lengths at age for walleyes were estimated using Lee's equation to back calculate length to specific ages. The walleye intercept value used was 55 mm.

Relative weight values were statistically tested across length categories using one-way analysis of variance (Steel and Torrie 1980). When a significance difference was identified across length categories, Fishers Least Significant Difference (LSD; Steel and Torrie 1980) was used to separate means. Statistical analyses were completed using Systat 10.2 (Systat 2002) and statistical significance was set at $P < 0.05$.

Oxytetracycline Marking and Detection

In both 1999 and 2002, 9 million walleye fry were marked with oxytetracycline (OTC) at Blue Dog State Fish Hatchery prior to being stocked into Waubay Lake. Marking procedures followed those outlined by Lucchesi and Scubelek (2001). Each year, walleye fry were marked in six different lots of 1.5 million fry each. Walleye fry were immersed for 6 h in a 683-L fiberglass raceway in which 543 g OTC and 700 g sodium phosphate (dibasic Na2HPO4) had been added in solution. In 1999, concentrations of total OTC ranged from 540 ppm to 699 ppm (mean = 618 ppm, SE = 23.58) and the concentration of OTC in solution ranged from 194 ppm to 286 ppm (mean = 225, SE = 16.25). Analyses on concentrations were not completed on 2002 samples. OTC concentrations were determined at the South Dakota State University Biochemistry Analytical Services Laboratory.

Age-0 walleye were collected during fall nighttime electrofishing in 1999 and 2002. Otolith preparation and viewing followed the procedures given in Lucchesi and Scubelek (2001). Sagittal otoliths were removed, affixed concave side down on a glass slide with cyanoacrylic cement and sanded with wet 600- to 1500-grit sandpaper. Otoliths were viewed for the presence or absence of a fluorescent mark using an epi-fluorescent microscope.

Table 1. Gill net and frame net sample dates and effort for Waubay Lake, South Dakota 1997 - 2002.

| | | Effort | |
|---|---|---|---|
| Year | Dates | Gill Nets | Frame Nets |
| 1997 | August 13 - 15 | 6 | 29 |
| 1998 | August 11 - 14 | | 32 |
| 1999 | August 17 - 20 | 8 | 23 |
| 2000 | August 15 - 18 | 8 | 32 |
| 2001 | August 21 - 24 | 8 | 32 |
| 2002 | August 20 - 23 | 8 | 32 |

Table 2. Electrofishing sample dates, surface water temperature ( $^{\circ}$C), conductivity (uS), and effort (s) for Waubay Lake, South Dakota 1998 - 2002.

| Year | Date | Temperature | Conductivity | Effort |
|---|---|---|---|---|
| 1998 | August 31 | -- | -- | 3,900 |
| 1999 | September 22 | 15.3 | 1,526 | 3,720 |
| 2000 | October 12 | 9.7 | 1,393 | 3,542 |
| 2001 | September 10 | 16.8 | 1,480 | 2,400 |
| 2001 | October 22 | 10.6 | 1,386 | 1,222 |
| 2002 | September 10 | 23.1 | 1,900 | 3,834 |

Table 3. Minimum total lengths (mm) for Gabelhouse (1984) length categories for selected fish species.

| Species | Stock (S) | Quality (0) | Preferred (P) | Memorable (M) | Trophy (T) |
|---|---|---|---|---|---|
| Black bullhead | 150 | 230 | 300 | 380 | 460 |
| Black crappie | 130 | 200 | 250 | 300 | 380 |
| Common carp | 280 | 410 | 530 | 660 | 840 |
| Northern pike | 350 | 530 | 710 | 860 | 1120 |
| Smallmouth bass | 180 | 280 | 350 | 430 | 510 |
| Walleye | 250 | 380 | 510 | 630 | 760 |
| White bass | 150 | 230 | 300 | 380 | 460 |
| Yellow perch | 130 | 200 | 250 | 300 | 380 |

Angler Use and Sport Fish Harvest

A roving angler use and harvest survey with two-stage stratification was completed during May through August and December through March each year, except in 1998 when March was not included in the winter survey. The first stratification unit was between weekdays and weekend days and the second stratification was for the time periods that the clerk was present. Because weekends typically receive increased fishing pressure most weekend days were represented in the survey. Time periods were randomly assigned to available days with weekdays and weekend days being treated separately when times were assigned.

The survey utilized instantaneous angler counts combined with angler interviews. Instantaneous angler counts provided fishing pressure estimates and angler interviews provided information necessary for estimating fish species catch rates, mean angler trip length, and mean party size. Two instantaneous counts of the total number of boats fishing and all shoreline anglers present were made each day during open-water periods and during ice cover all active ice shacks and open-ice anglers were counted. When counts were not being made, anglers were contacted and interviewed. Angler use and harvest estimates prior to 2001 were computed using the software designed by Jacobson (1988) and modified by Dave Lucchesi (personal communication, SDGFP). Following 2001, Creel Application Software (CAS) designed by Craig Soupir (Soupir and Brown 2002) was used.

Additional questions asked during interviews were used to obtain angler primary residence, fish species targeted, and two questions concerning angler opinions were asked. A sample of angler caught fish was measured (TL) during the interview process.

## Fish Community Surveys

*Walleye*

Recruitment

Walleye fry stocking was initiated in 1994 and continued through 1996 (Table 4). Walleye fry were again stocked in 1999 and 2002 (Table 4). Survival from the initial three stocks and the 1999 stocking were successful as indicated by the corresponding presence of each year class (Figure 2). It appears that stocking in 2002 produced a weak year class. The failure in 2002 may be related to cold weather conditions occurring at the time of stocking. Walleye year class strength from non-stocked years has been dismal.

Fall electrofishing CPUE of age-0 walleyes during non-stocked years ranged from 2.9 to 26.8 (Table 5). In 1999, a stocked year, the age-0 electrofishing CPUE was 589.5 (Table 5). Lucchesi and Scubelek (2001) classified fall age-0 walleye year class strength on the number of fall age-0 walleyes collected per electrofishing hour for South Dakota waters with the following scale, weak (CPUE < 22), moderate ($22 \leq$CPUE<55), moderately-strong (55<CPUE<160) and strong (CPUE > 160). Using this scale, the 1999 year class was classified strong, the 2000 year class was moderate and all others were weak (Table 5).

In the 2001 gill net sample, the CPUE for the 1999 year class (age-2) walleyes was 27.1 (Table 5). The 1998 year class which was classified as weak based on fall age-0 electrofishing CPUE had a gill net CPUE of 4.0 at age-2 indicating a weak year class. The 2000 year class which based on age-0 electrofishing was moderate had a gill net CPUE of 2.2 at age-2 indicating a weak year class. Although more data are needed and an adjusted age-0 CPUE classification may be needed, it appears that age-0 fall electrofishing CPUE may be a good predictor of walleye year class strength at Waubay Lake. In addition to age-0 CPUE, size and condition of age-0 walleyes collected during fall electrofishing may need to be considered when predicting year-class strength.

Fifty-four age-0 walleye otoliths collected during 1999 were examined to detect the presence or absence of an OTC mark. Of the walleyes examined, 43 (80%) were found to have an OTC mark. Chi-square analysis indicated that the observed ratio (80:20) of marked to unmarked walleyes was significantly different ($X^2 = 3.9$; $P < 0.05$) from the expected ratio (67:33). Although a non-significant difference in observed verses expected would have indicated that non-stocked fish contributed little to the 1999 year class; the significant difference identified indicates that marked fish were collected in a higher proportion than unmarked. The results indicate that the 1999 year class was primarily composed of OTC marked fry. Thus, it is probable that the OTC-marked fry had higher survival than non-marked fry. In 1999, the OTC-marked fry were the first to be stocked into Waubay Lake.

Reasons behind the poor natural recruitment at Waubay Lake are of great concern, but currently unknown. In 2002, eggs from 10 Waubay Lake females were fertilized with sperm from Waubay Lake males. Eggs were viable and fry were produced, but survival following hatching is unknown. It is possible that the large 1996 and 1999 year classes suppressed subsequent year classes. Li et al. (1996) believed that cannibalism on younger year classes could be a decisive factor in regulating year-class abundance because it could act over a long period of

time. Unless natural recruitment occurs, stocking will be necessary to maintain the walleye fishery.

Population Abundance and Size Structure

The 1997 gill net sample revealed the presence of three walleye year classes due to stockings made from 1994 to 1996 (Figure 2). Through 2002, these year classes have provided the bulk of the walleye harvest at Waubay Lake. In 1997 and through October 1998 no walleye length restrictions were in place on Waubay Lake allowing anglers to harvest fish from all three initial year classes. Beginning in October 1998, a 406-mm (16-in) minimum length limit was enacted, but by this time most walleyes exceeded 406 mm TL. Recruitment following the 1996 year class was minimal until the 1999 year class was produced by fry stocking.

Walleye population size structure and population abundance has been influenced by recruitment patterns. In 1997, the presence of the 1996 year class led to a PSD of 28, but as the year class matured the PSD and RSD-P increased in subsequent years because of a lack of recruitment (Table 6). In 2001, the PSD decreased to 14. The decrease in size structure was because the 1999 year class recruited to our gill nets resulting in an increase in stock- to quality-length walleyes in the sample. The highest gill net CPUEs for stock-length walleyes have coincided with the recruitment of two large year classes (1996 and 1999) to our gill nets (Table 6).

Condition

Waubay Lake walleyes generally have been in good to excellent condition. In 1997 and 1998, relative weights (Wr) of stock-length walleyes averaged 100 (Table 7). A slight decrease in condition was noted in 1999 with the greatest decline present in the sub-stock (<250 mm) fish (Table 7). Relative weight average values in 2000 fell below 90 for all length categories. The reduced Wr values in 2000 resulted from poor natural reproduction of most fish species during 2000 limiting walleye prey availability. Relative weight values increased to the mid 90's in 2001, but again dropped into the 80's in 2002 (Table 7). It appears that the abundance of potential walleye prey was limited in 2002. Relative weight values in the 80's are common for walleyes during summer months in northeast South Dakota lakes.

Length related trends in Wr values were not strongly defined. Significant differences in condition across length groups were identified in 1999 and 2001 (Table 7). In 1999, sub-stock walleyes had significantly lower condition and in 2001 the preferred-to-memorable-length walleye condition was lower than other length groups.

Growth

Similar to other new and expanded water bodies located in northeastern South Dakota, walleye growth has been excellent. Mean back-calculated total lengths at age tend to exceed the region IV mean (Table 8).

Waubay Lake walleye growth was correlated with walleye Wr values observed in August. Annual growth increments added were greatest during years when Wr values averaged

100 (Figure 3; Table 7). Moderate growth occurred during 1999 and 2001 when Wr values were in the mid 90's (Figure 3; Table 7). The poorest observed growth occurred in 2000 when stock-length Wr values averaged 86 (Figure 3; Table 7). The length increment added in 2002 will likely resemble that observed in 2000 based on Wr values of walleyes collected during August 2002.

Walleye back-calculated lengths at age typically have exceeded the South Dakota Region IV average with the exception of the 1999 year class (Table 8). This year class has been approximately one year behind the Region IV average. Based on past walleye growth history, three scenarios of predicted growth (worst, average, and best) of the 1999 year class were made (Figure 4). In August 2002, the 1999 year class had a mean length of 354 mm. In the worst case growth scenario 62 mm will be added to 354 mm, at average growth 82 mm would be added, and in the best growth case 92 mm will be added by August 2003. In all scenarios, a majority of the year class will surpass 406 mm by August 2003 (Figure 4). Thus, the 1999 year class will likely become a large component of the angler creel in 2003.

Table 4. Year, species, size, and number stocked at Waubay Lake, South Dakota, 1994-2002.

| Year | Species | Size | Number |
|---|---|---|---|
| 1994 | yellow perch | juvenile | 9,100 |
| 1994 | walleye | fry | 9,900,000 |
| 1995 | walleye | fry | 19,700,000 |
| 1996 | walleye | fry | 18,764,000 |
| 1999 | walleye | fry | 13,449,000 [a] |
| 2000 | smallmouth bass | fingerling | 25,540 |
| 2001 | smallmouth bass | fingerling | 26,900 |
| 2002 | walleye | fry | 9,000,000 [a] |

a - 9 million fry marked with oxytetracycline (OTC)

Table 5. Walleye individual year class age-0 electrofishing catch rates (CPUE; number per h), age-0 mean TL (mm) at capture, and mean age-1 and age-2 gill net catch rates (CPUE; number per net) at Waubay Lake, South Dakota.

| | Electrofishing | | Gill net CPUE | |
|---|---|---|---|---|
| Year Class | Age-0 CPUE | Mean Age-0 TL | Age-1 | Age-2 |
| 1998 | 4.8(l.20) | 189 (2.36) | 1.6 (0.44) | 4.0 (0.46) |
| 1999 | 589.5 (118.86) | 156 (0.22) | 6.6(l.89) | 27.1 (5.66) |
| 2000 | 26.8 (3.20) | 154 (3.00) | 0.3 (0.07) | 2.2 (0.40) |
| 2001 | 2.9(l.99) | 196 (13.96) | 0.1(0.13) | |
| 2002 | 2.9 (2.01) | 153 (2.67) | | |

Table 6. Mean stock length gill net catch per unit effort (CPUE; SE in parentheses), proportional stock density (PSD; 90% CI in parentheses) and relative stock density of preferred-length (RSD-P; 90% CI in parentheses) estimates for walleyes collected at Waubay Lake, South Dakota during August 1997-2002.

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| Stock CPUE | 20.0 (5.01) | 8.0 (3.41) | 14.7 (2.90) | 9.3 (1.03) | 30.3 (6.18) | 34.6 (5.22) |
| PSD | 28 (21-34) | 94 (88-99) | 89 (85-94) | 72 (63-80) | 14(10-18) | 19(15-23) |
| RSD-P | 1(0-2) | 2(0-4) | 8(4-11) | 24(16-33) | 5(2-7) | 5(3-7) |

Table 7. Mean relative weight values by Gabelhouse (1984) length categories (standard error values are in parentheses) for walleyes collected at Waubay Lake, South Dakota during August 1997 - 2002. Analysis of variance resulting F-value and probability value for tests across length groups each year. Length-group mean values for each year with the same letter are not significantly different (P>0.05). (<S = sub-stock, S-Q = stock to quality length, Q-P = quality to preferred length, and P-M = preferred to memorable length, and M-T = memorable to trophy length).

| | <S | S-Q | Q-P | P-M | M-T | Stock | F-value | P-value |
|---|---|---|---|---|---|---|---|---|
| 1997 | | 100 (0.31) | 101 (0.98) | 100 [a] | | 100 (0.35) | 0.732 | 0.483 |
| 1998 | | 89 (5.48) | 100 (0.12) | 102 [a] | | 100 (0.11) | 0.178 | 0.838 |
| 1999 | 84 (1.88)z | 93 (1.66)y | 96 (0.07)y | 97 (0.65)y | | 96 (0.08) | 4.191 | 0.007 |
| 2000 | 86 (0.37) | 86 (0.38) | 85 (0.41) | 89 (0.63) | | 86 (0.38) | 1.408 | 0.244 |
| 2001 | 99 (3.98)z | 96 (0.03)zy | 95 (0.93)zy | 90 (2.27)y | 97 (a)zy | 95 (0.02) | 2.871 | 0.024 |
| 2002 | 99 (a) | 87 (0.11) | 85 (0.29) | 85 (0.68) | 86(l.27) | 86 (0.11) | 1.387 | 0.239 |

a - sample size insufficient to calculate SE

Table 8. Individual year class mean back-calculated total lengths for the last year of completed growth at ages 1-5 for walleyes collected at Waubay Lake, South Dakota and South Dakota Region IV back-calculated walleye total length mean of means (Willis et al. 2001).

| | Mean back-calculated total length at age (mm) | | | | |
|---|---|---|---|---|---|
| Year Class | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 |
| 2001 | 188 | | | | |
| 2000 | 161 | 279 | | | |
| 1999 | 144 | 219 | 319 | | |
| 1998 | 239 | 335 | 395 | 501 | |
| 1997 | 205 | 361 | 430 | 492 | 548 |
| 1996 | 182 | 342 | 443 | 500 | 560 |
| 1995 | 145 | 291 | 416 | 480 | 541 |
| SD Region IV | 161 | 281 | 367 | 433 | 497 |

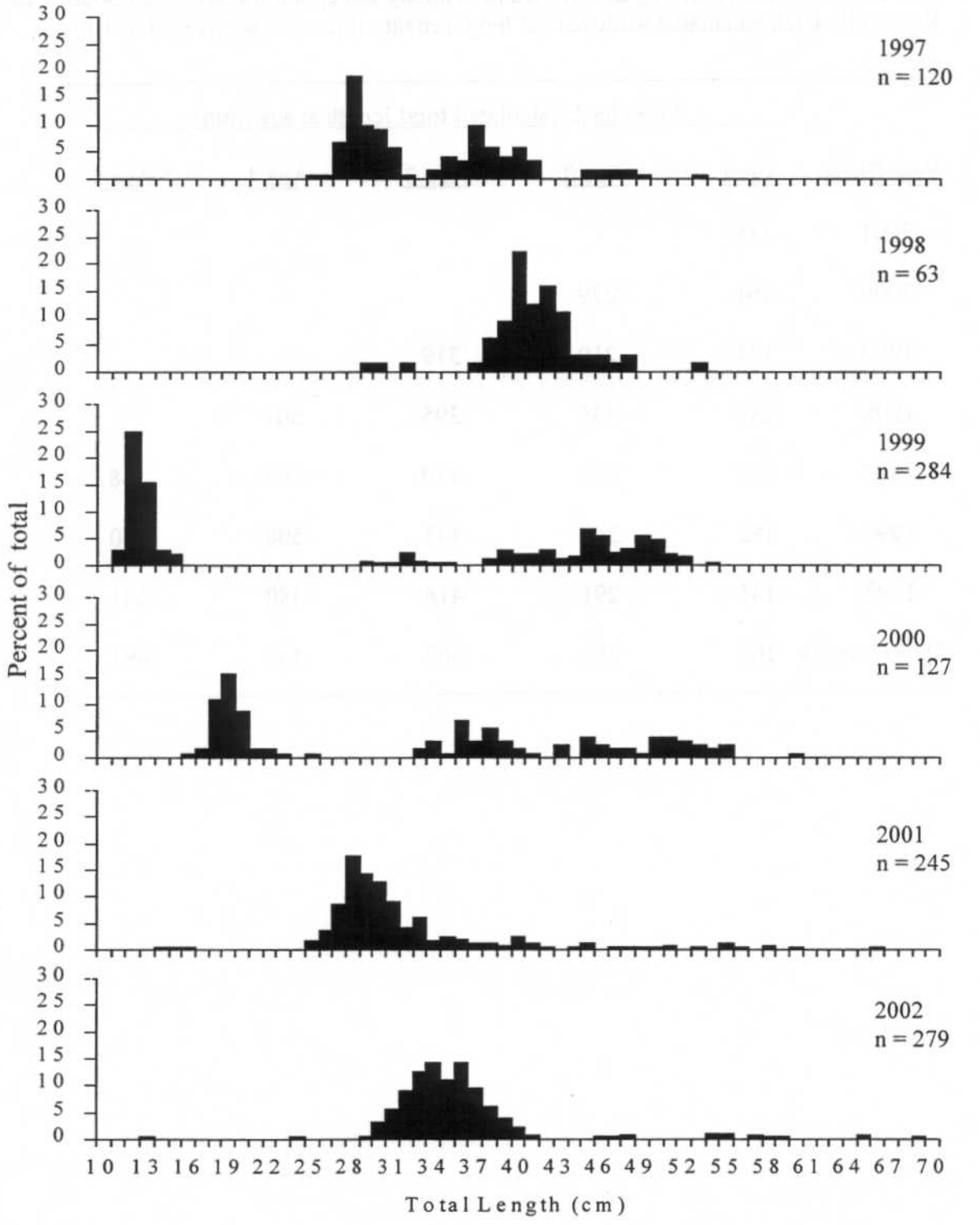


Figure 2. Length frequency histograms of gill net captured walleyes at Waubay Lake, South Dakota, during August 1997-2002, n is the number collected.

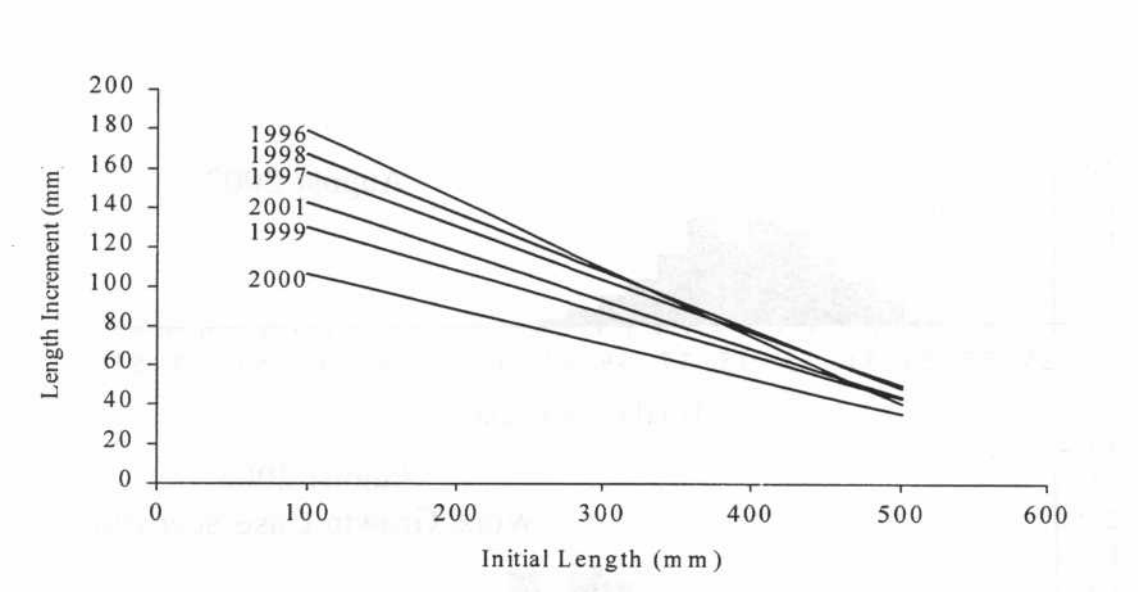


Figure 3. Regression lines of length increment (mm) that was added during each growing year plotted against walleye total length (mm) at the beginning of each year's growth.

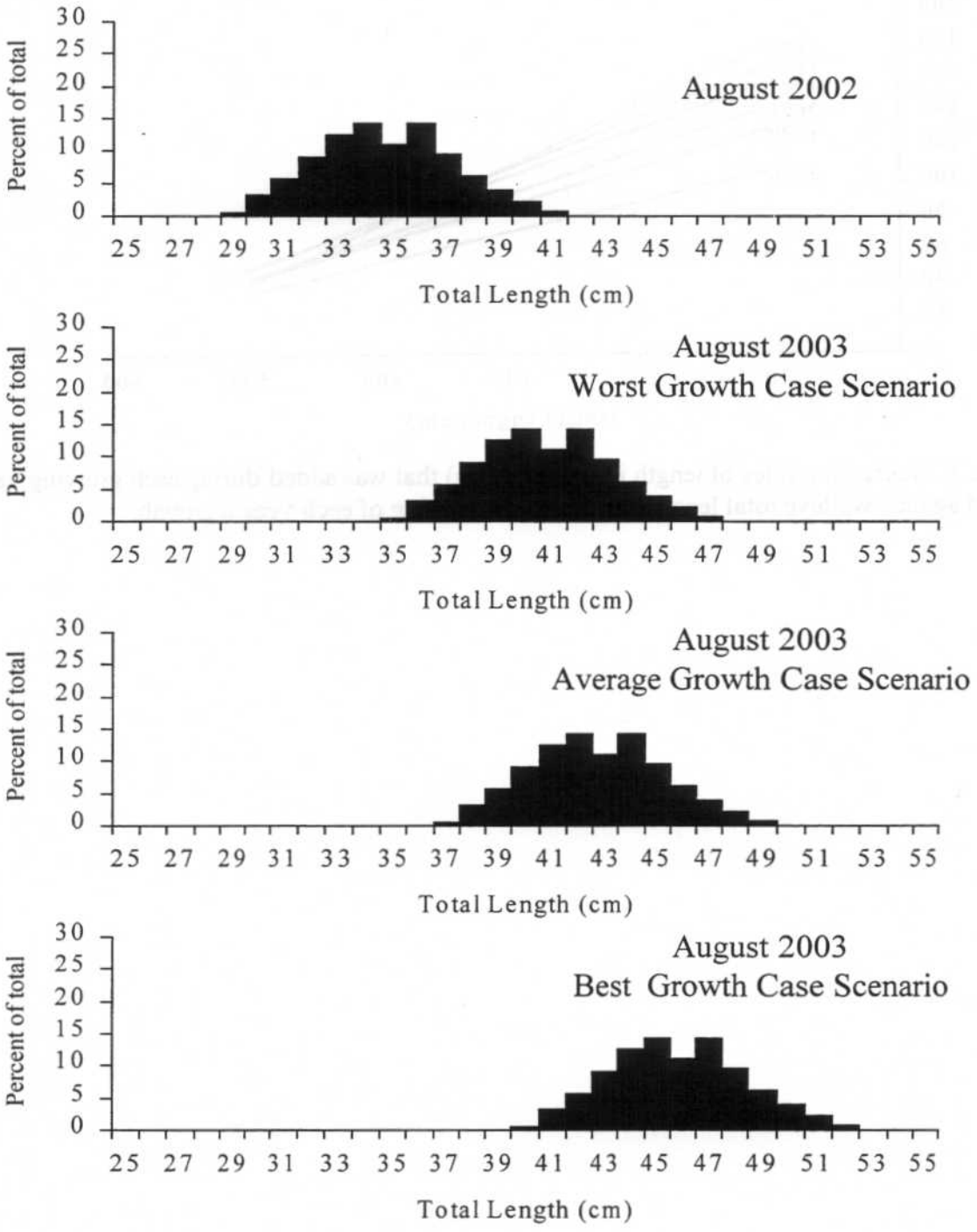


Figure 4. Length frequency distribution of the 1999 walleye year class in August 2002 and three potential growth scenarios for August 2003 length frequency distribution based on walleye growth history for Waubay Lake, South Dakota.

*Yellow Perch*

Population Abundance and Size Structure

Northeast South Dakota yellow perch populations tend to have variable recruitment with abiotic factors likely influencing the observed recruitment. At Waubay Lake, it appears that recruitment was consistent from 1997 to 1999 (Figure 5). The abundance of age-0 yellow perch appears to be high in the 1997 through 1999 gill net samples. Catches of age-0 yellow perch from 2000 to 2002 were not of the magnitude experienced during the time frame of 1997 to 1999 potentially indicating poor recruitment. However, yellow perch reproduction (as indicated by larval presence in tow samples and the number of juveniles collected during shoreline seining) appeared to be high during 2001 (personal communication Dan Isermann, SDSU). An abundance of yellow perch from 2001 has not materialized in our nets. It is likely that, the abundant 1999 walleye year class reduced recruitment of the 2001 yellow perch year class.

Stock-length yellow perch gill net CPUE values exceeded 60 from 1998 to 2001 (Table 9). The high CPUE from 1998 to 2001 is a result of consistent recruitment experienced during 1997 to 1999. The 2002 gill net CPUE was lower than that of prior years (Table 9). Yellow perch abundance will likely continue to decrease because of recent poor recruitment and high angler harvest.

Yellow perch size structure was reduced in 1998 and 1999 because the strong 1997 and 1998 year classes attained stock-length but not quality length (Table 9). Since 1998 the PSD has increased with a high of 96 in 2002 (Table 9). The 2002 RSD-P was 52 (Table 9). The high PSD and RSD-P are indicative of the poor yellow perch recruitment experienced in recent years.

Condition

Yellow perch condition has been excellent at Waubay Lake. Length category Wr values typically exceeded 100 (Table 10). No strong length related trends in condition were apparent. However, significant differences in Wr values across lengths were identified in 2000, 2001, and 2002. Condition remained excellent with the lowest identified mean Wr (93) occurring during 2000 in the preferred- to memorable-sized yellow perch (Table 10). Limited food resources does not appear to be a problem with Waubay Lake yellow perch.

Growth

Because Waubay Lake is a newly expanded lake, growth of most fishes generally would be considered good to excellent. However, through the sampling period yellow perch growth analysis has not been completed by SDGFP. In 2001, as part of a research project being completed at South Dakota State University yellow perch collected during the 2001 sample were aged and the mean length at the time of capture for each age determined (personal communication, Dan Isermann, South Dakota State University). Mean TL at capture for ages 1 - 4 were as follows, age 0 - 93 mm (SE = 0.78), age 1 - 145 mm (SE = 2.45), age 2 - 187 mm (SE = 1.25), age 3 - 214 mm (SE = 1.22), and age 4 - 239 mm (SE = 1.19). The mean lengths at capture were similar to the South Dakota statewide mean back-calculated lengths at age reported by Willis et al. (2001).

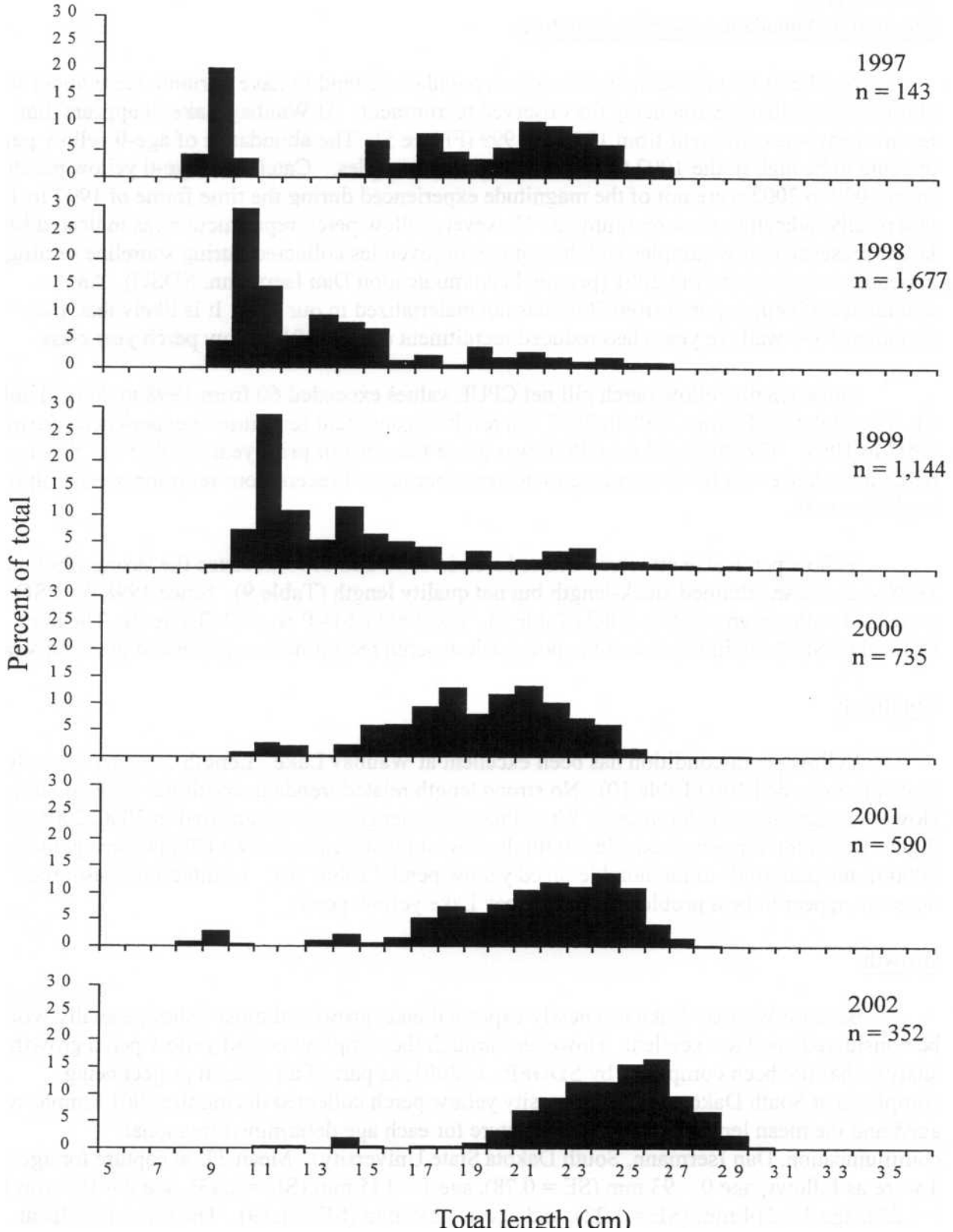


Figure 5. Length frequency histograms of gill net captured yellow perch at Waubay Lake, South Dakota, during August 1997-2002, n is the number collected.

Table 9. Mean stock length gill net catch per unit effort (CPUE; SE in parentheses), proportional stock density (PSD; 90% CI in parentheses) and relative stock density of preferred-length (RSD-P; 90% CI in parentheses) estimates for yellow perch collected at Waubay Lake, South Dakota during August 1997-2002.

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| Stock CPUE | 17.2 (4.63) | 94.3 (33.37) | 60.2 (13.97) | 87.1 (14.43) | 70.9 (10.10) | 43.8 (7.96) |
| PSD | 62 (54-70) | 25 (23-28) | 30 (27-33) | 53 (50-56) | 75(72-78) | 96(95-98) |
| RSD-P | 6(2-10) | 4(3-5) | 8(6-10) | 2(1-3) | 17(15-20) | 52(47-56) |

Table 10. Mean relative weight values by Gabelhouse (1984) length categories (standard error values are in parentheses) for yellow perch collected at Waubay Lake, South Dakota during August 1997 - 2002. Analysis of variance resulting F-value and probability value for tests across length groups each year. Length-group mean values for each year with the same letter are not significantly different (P>0.05). (<S = sub-stock, S-Q = stock to quality length, Q-P = quality to preferred length, and P-M = preferred to memorable length).

| | <S | SQ | Q-P | P-M | Stock | F-value | P-value |
|---|---|---|---|---|---|---|---|
| 1997 | | 113 (1.06) | 112 (0.67) | 110 (0.66) | 112 (0.55) | 0.146 | 0.864 |
| 1998 | 103 (2.25) | 105(1.63) | 112 (2.63) | 104 (3.58) | 106(1.35) | 1.548 | 0.206 |
| 1999 | 104 (2.90) | 107(1.10) | 101 (0.91) | 103 (2.77) | 106 (0.82) | 1.920 | 0.112 |
| 2000 | 110 (1.58)z | 103 (0.62)y | 100 (0.37)x | 93 (0.76)w | 102 (0.34) | 9.161 | <0.001 |
| 2001 | 104 (0.00)zy | 110 (0.60)z | 109 (0.31)z | 106 (0.39)zy | 108 (0.24) | 3.319 | 0.020 |
| 2002 | 104 (7.64)zy | 108 (7.53)z | 109 (0.58)z | 101 (0.51)y | 105 (0.37) | 13.690 | <0.001 |

*Northern Pike*

Population abundance and size structure

Northern pike net catches were low during 1997 to 2002. Northern pike gill net mean CPUE values ranged from 0.2 to 2.3 and frame net means ranged from 0.8 to 2.1 (Table 11). These values are likely not indicative of the at-large northern pike population abundance because northern pike likely are not effectively sampled during late summer. Neumann and Willis (1995) believed that the best time to sample northern pike populations with gill nets in South Dakota natural lakes was late spring following spawning.

Size structure of the northern pike gill net and frame net samples was high during the 6 year period with PSD values often exceeding 80 and RSD-P values >20 (Table 11). At Lake Thompson, South Dakota, Neumann and Willis (1995) found that the size structure of northern pike captured in gill nets was lowest in the summer and during the spring spawning period.

Condition

Relative weight values for all length categories exceeded 90 in 1997, 1998, and 1999 (Table 12). Reduced condition was observed in the 2000 to 2002 samples with stock-length Wr values averaging from 80 to 87 (Table 12). Northern pike Wr in the August sample likely represent a seasonal low in condition for northern pike. Neumann and Willis (1995) found northern pike Wr values to be lowest following spawning and through the summer before rising in the fall and peaking in the winter at Lake Thompson, South Dakota.

*Black Crappie*

Population abundance and size structure

Black crappie abundance in 1997 was low with only three stock-length and two sub-stock crappies captured in 29 frame net nights of effort. In 1998, the stock-length CPUE increased to 4.1 likely the result of recruitment of the 1997 cohort (Table 13). A second year class was present in 1999, but the abundance of the 1998 year class appeared to be less than that of the 1997 year class (Figure 6). Recruitment has been minimal since the 1998 year class resulting in a population dominated by fish exceeding 250 mm TL (Figure 6). Because of the lack of recruitment and the maturing of the two year classes PSD has exceeded 75 and RSD-P exceeded 30 in the 2000 to 2002 samples (Table 13). Stock-to quality-length black crappies were present in the 2002 sample (Figure 6). The presence of the stock-to quality-length black crappies represent the first recruitment since the 1998 year class. Recruitment will be needed for the Waubay Lake black crappie fishery to continue.

Condition

Black crappie condition was excellent in the 1997 to 2002 samples. Relative weight values exceeded 100 for all length categories during this period (Table 14). Significant differences in Wr values across length categories were identified in 2000, 2001, and 2002, but Wr values for all length categories remained above 100 (Table 14).

Table 11. Mean stock length gill net and frame net catch per unit effort (CPUE; SE in parentheses), proportional stock density (PSD; 90% CI in parentheses) and relative stock density of preferred-length (RSD-P; 90% CI in parentheses) estimates for northern pike collected at Waubay Lake, South Dakota during August 1997-2002.

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| Gill Net | | | | | | |
| Stock CPUE | 0.2 (0.17) | 2.3 (0.88) | 2.3 (0.82) | 0.6 (0.38) | 1.6 (0.32) | 1.0 (0.27) |
| PSD | a | 50 (29-71) | 82 (67-96) | a | 92(79-100) | a |
| RSD-P | a | 6(0-15) | 27(11-44) | a | 8(0-21) | a |
| Frame Net | | | | | | |
| Stock CPUE | 1.8 (0.30) | 0.8 (0.17) | 0.9 (0.28) | 2.1 (0.26) | 1.4 (0.26) | 0.9 (0.19) |
| PSD | 88 (81-96) | 88 (76-99) | 80 (64-96) | 89 (83-96) | 83 (73-92) | 97 (91-100) |
| RSD-P | 15 (7-24) | 29 (13-45) | 25 (8-42) | 29 (19-38) | 43 (31-56) | 31 (16-46) |

a - sample size insufficient to calculate index

Table 12. Mean relative weight values by Gabelhouse (1984) length categories (standard error values are in parentheses) for northern pike collected with gill nets at Waubay Lake, South Dakota during August 1997 - 2002. Analysis of variance resulting F-value and probability value for tests across length groups for each year. Length-group mean values for each year with the same letter are not significantly different (P>0.05). (<S = sub-stock, S-Q = stock to quality length, Q-P = quality to preferred length, and P-M = preferred to memorable length).

| | <S | S-Q | Q-P | P-M | Stock | F-value | P-value |
|---|---|---|---|---|---|---|---|
| 1997 | 90 (0.76) | | 102 (a) | | 102 (a) | 48.0 | 0.091 |
| 1998 | | 94 (2.81) | 98 (2.93) | 98 (a)- | 96(l.91) | 2.231 | 0.144 |
| 1999 | | 94 (2.10) | 93 (2.09) | 91 (3.11) | 93(l.42) | 0.150 | 0.862 |
| 2000 | | | 91 (4.39) | 82(l.39) | 87 (3.22) | 1.982 | 0.254 |
| 2001 | | 72 (a)z | 85 (1.29)y | 92 (a)y | 85(l.58) | 4.607 | 0.038 |
| 2002 | | | 78(l.42) | 82 (2.90) | 80(l.90) | 0.719 | 0.429 |

Table 13. Mean stock length frame net catch per unit effort (CPUE; SE in parentheses), proportional stock density (PSD; 90% CI in parentheses) and relative stock density of preferred-length (RSD-P; 90% CI in parentheses) for black crappie collected at Waubay Lake, South Dakota during 1997-2002.

| Parameter | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| Stock CPUE | 0.1 (0.08) | 4.1 (0.73) | 1.5 (0.47) | 3.7 (0.75) | 4.1(1.27) | 4.5(l.05) |
| PSD | [a] | 3(1-6) | 78(66-91) | 100[b] | 100[b] | 88(83-92) |
| RSD-P | [a] | 2(0-4) | 34(20-49) | 55(47-62) | 98(97-100) | 88(83-92) |

a - sample size insufficient to calculate index
b - inappropriate to calculate confidence interval when value equals 100

Table 14. Mean relative weight values by Gabelhouse (1984) length categories (standard error values are in parentheses) for black crappie collected with frame nets at Waubay Lake, South Dakota during August 1997 - 2002. Analysis of variance resulting F-value and probability value for tests across length groups for each year. Length-group mean values for each year with the same letter are not significantly different (P>0.05). (<S = sub-stock, S-Q = stock to quality length, Q-P = quality to preferred length, and P-M = preferred to memorable length).

| Year | <S | S-Q | Q-P | P-M | M-T | Stock | F-value | P-value |
|---|---|---|---|---|---|---|---|---|
| 1997 | | 121 (a) | | 122 (0.00) | | 122 (0.14) | 0.083 | 0.800 |
| 1998 | | 124 (1.07) | 122[a] | 117(l.17) | | 124 (1.05) | 0.365 | 0.697 |
| 1999 | | 113 (1.80) | 112 (0.00) | 110 (0.57) | | 112 (0.46) | 0.581 | 0.565 |
| 2000 | 125 [a]z | | 110 (0.25)y | 104 (0.27)x | 104 (0.80)x | 106 (0.35) | 16.504 | <0.001 |
| 2001 | | | 118 (6.13)z | 112 (0.20)z | 108 (0.56)y | 111 (0.28) | 6.727 | 0.002 |
| 2002 | 113[a]z | 122 (3.57)y | | 108 (0.33)x | 104 (0.15)zyx | 107(0.44) | 12.015 | <0.001 |

a - sample size insufficient to calculate SE

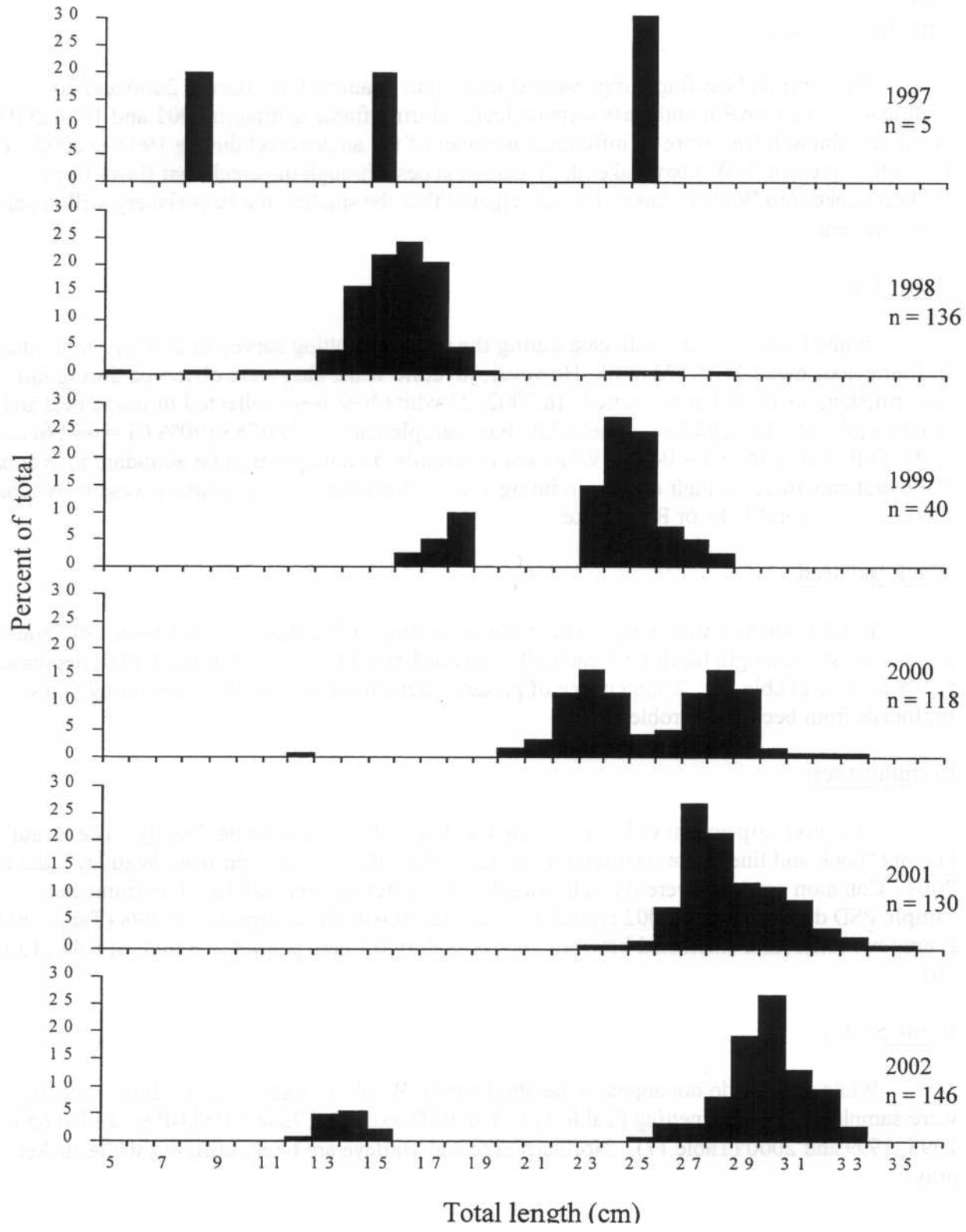


Figure 6. Length frequency histograms of frame net captured black crappie at Waubay Lake, South Dakota, during August 1997-2002, n is the number collected.

*Other Species*

Smallmouth Bass

Smallmouth bass fingerlings were stocked into Waubay Lake during 2000 and 2001 (Table 4). Seven smallmouth bass were collected during frame netting in 2001 and 16 in 2002. Adult smallmouth bass were an infrequent member of the angler creel during 1997 to 2002. The few adults present in Waubay Lake likely gained access through the creek that flows from Pickerel Lake into Waubay Lake. It is anticipated that the smallmouth bass fishery will develop in future years.

White Bass

White bass were first collected during the standard netting survey in 2001(12 individuals in frame nets; mean TL = 172 mm). However, juvenile white bass were observed during fall electrofishing in 1999, but not netted. In 2002, 23 white bass were collected in frame nets and one in a gill net. The *2002* frame net white bass sample had a PSD of 83 (90% CI = 66-96) and an RSD-P of 10 (90% *CI = 0-21).* White bass currently do not appear to be abundant in Waubay Lake, but may increase their density in future years. White bass likely gained access to Waubay Lake from Pickerel Lake or Rush Lake.

Black Bullhead

Black bullheads were not abundant during netting at Waubay Lake between 1997 and 2002. The stock-length black bullhead CPUE in 2001 was highest at 12.5, but CPUE decreased to 0.8 in *2002* (Table 15). Maintenance of predator densities is essential at preventing black bullheads from becoming problematic.

Common Carp

Common carp appear to be present in Waubay Lake at a moderate density. The South Dakota "hook and line" state record common carp (16,798 g) was caught from Waubay Lake in *2001*. Common carp that were typically caught during netting were adults. The frame net sample PSD during 1997 to *2002* typically exceeded 80 with the exception of 1998 (Table 16). Frame net catch rates fluctuated between approximately 0.1 carp per net to a high of 6.44 (Table 16).

White Sucker

White suckers do not appear to be abundant in Waubay Lake. A few adults typically were sampled during gill netting (Table 17). The PSD exceeded 75 and RSD-P exceeded 65 in 1998, 1999 and *2000* (Table 17). Northern pike and walleye are likely utilizing white suckers as prey.

Lake Herring

A single lake herring was collected during gill netting in 2002. This individual was likely the progeny of lake herring that were hatched at Blue Dog State Fish Hatchery. Adult lake herring were commonly collected during gill net surveys at Blue Dog Lake, South Dakota in the 1990's. It is probable that fish moved from Blue Dog Lake into Waubay Lake.

*Mercury Sampling*

The South Dakota Department of Health (SDDH) tested fish flesh from Waubay Lake to assess mercury levels in 1999, 2000, and 2001. Mercury levels were derived from a composite sample consisting of five fish. The SDDH follows the Food and Drug Administration's (FDA) mercury action level of lppm. When fish flesh levels are at or close to 1 ppm, the SDDH recommends that people space their meals of such fish to limit consumption to safe levels. The recommended consumption levels are that healthy adults eat no more than 7 ounces of fish per week. Women, who plan to become pregnant, are pregnant or are breast-feeding, and children under age seven should eat no more than one 7-ounce meal of such fish per month.

In 1999 composite samples for black crappie, walleye, white sucker, and yellow perch were examined. Sample results showed mercury levels of 0.14 ppm for black crappie, 0.21 ppm for walleye, 0.01 for white sucker, and 0.25 for yellow perch. All of these levels were well below the FDA action level.

Composite samples were collected in 2000 from black crappie, northern pike, yellow perch, walleye, and white sucker. The walleye sample in 2000 consisted of 10 composite samples, but the other species were single composites. Mercury levels for black crappie (0.12 ppm), white sucker (0.005 ppm), and yellow perch (0.26 ppm) were similar to 1999 levels. The northern pike composite had a mercury level of 0.27 ppm. The walleye composite samples ranged from 0.27 to 0.63 ppm. Walleye composite samples that had an average walleye length of less than 360 mm had mercury levels of 0.36 and less. Walleye composite samples that averaged greater than 360 mm had mercury levels that exceeded 0.45 ppm. The FDA action level was not reached by any samples.

Nine walleye composite samples were tested for mercury in 2001. As in 2000, the samples from larger fish had the highest mercury levels. Walleye composite samples that had an average walleye length greater than 507 mm had mercury levels in excess of 0.5 ppm while composites from smaller walleyes did not exceed 0.3 ppm. As in previous sampling, mercury levels in walleye did not exceed the FDA action level.

Table 15. Mean stock length frame net catch per unit effort (CPUE; SE in parentheses), proportional stock density (PSD; 90% CI in parentheses) and relative stock density of preferred-length (RSD-P; 90% CI in parentheses) for black bullhead at Waubay Lake, South Dakota during August 1997-2002.

| Parameter | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| Stock CPUE | 0.0 | 0.0 | 0.26 (0.11) | 0.7 (0.32) | 12.5(6.48) | 0.8 (0.49) |
| PSD | | | [a] | 78(63-93) | 87 (84-90) | [a] |
| RSD-P | | | [a] | 13(1-25) | 27(23-30) | [a] |

a - sample size insufficient to calculate index

Table 16. Mean stock length frame net catch per unit effort (CPUE; SE in parentheses), proportional stock density (PSD; 90% CI in parentheses) and relative stock density of preferred-length (RSD-P; 90% CI in parentheses) for common carp at Waubay Lake, South Dakota during August 1997-2002.

| Parameter | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| Stock CPUE | 0.5 (0.17) | 2.4 (0.57) | 6.4 (2.44) | 1.3 (0.31) | 3.8 (0.79) | 0.1 (0.06) |
| PSD | 100[6] | 21 (13-28) | 82(77-88) | 98(93-100) | 97(94-99) | [a] |
| RSD-P | 93(80-100) | 17(10-24) | 15(10-20) | 90(82-98) | 42(35-50) | [a] |

a - sample size insufficient to calculate index
b - inappropriate to calculate confidence interval when value equals 100

Table 17. Mean stock length gill net catch per unit effort (CPUE; SE in parentheses), proportional stock density (PSD; 90% CI in parentheses) and relative stock density of preferred-length (RSD-P; 90% CI in parentheses) for white sucker at Waubay Lake, South Dakota during August 1997-2002.

| Parameter | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| Stock CPUE | 1.7 (0.67) | 3.13 (1.26) | 10.5(l.99) | 6.5(l.15) | 0.25 (0.16) | 0 |
| PSD | [a] | 79(65-94) | 96(93-100) | 100' | [a] | |
| RSD-P | [a] | 67(50-84) | 69(61-77) | 87(79-95) | [a] | |

a - sample size insufficient to calculate index
b - inappropriate to calculate confidence interval when value equals 100

## Angler Use and Harvest Surveys

*Open-water*

Fishing Pressure

Waubay Lake anglers primarily targeted walleyes during open-water periods between 1997 and 2002 (Table 18). This is similar to many South Dakota waters. Stone and Sorensen (2002) reported that in excess of 92 % of anglers fishing at Lake Francis Case, South Dakota targeted walleyes from 1997 through 2001. In 2001, 82% of anglers fishing at Lake Oahe, South Dakota targeted walleyes (Lott et. al 2002). In past surveys, anglers fishing in South Dakota have continually ranked walleyes as the most sought after fish species (McPhillips 1989; Mendelsohn 1994).

Fishing pressure in 1997 was minimal and a measurable increase in pressure was not observed until July and August 1998 (Table 19). The peak observed open-water fishing pressure occurred in 1999 when the total angler h exceeded 260,000 h (Table 19). Following 1999, open-water pressure has declined likely the result of reduced walleye angling success. In 1999, open-water fishing pressure was relatively high during all surveyed months with the highest pressure observed during June and August. Since 1999, May has been the peak open-water fishing pressure month (Table 19).

In addition to a decline in angling pressure following 1999, an increased percentage of anglers targeted species other than walleyes during open-water fishing, but walleyes have remained the most sought after species (Table 18). Anglers targeting yellow perch, black crappies, and anything increased following 1999. The percentage of anglers targeting northern pike while open-water fishing has drastically decreased since 1997 when 22.7% of the anglers indicated they were targeting northern pike (Table 18).

The average open-water angling party size exceeded two anglers during all open-water survey years (Table 20). Monthly open-water trip lengths ranged from 3.5 h (June 1997) to 6.0 h (June 1999) with overall averages typically exceeding 5.0 h (Table 20). Mean party size and trip lengths were similar to those observed on the South Dakota Missouri River reservoirs. Stone and Sorensen (2002) reported that Lake Francis Case, South Dakota had a mean party size of 2.2 anglers and trip length of 5.1 h in 2001, Lott et al. (2002) indicated that Lake Oahe had a mean party size of 2.3 anglers and trip length of 4.9 h in 2001, and in 2000 at Lake Sharpe, South Dakota a mean party size of 2.5 anglers and a trip length of 4.5 h was reported (Johnson and Lott 2001).

Table 18. Primary open-water target species by anglers fishing Waubay Lake, South Dakota during 1997 to 2002 (May - August) expressed as a percentage of total angling trips.

| | Percentage (%) | | | | | |
|---|---|---|---|---|---|---|
| Target species | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| Walleye | 64.2 | 83.6 | 86.4 | 66.8 | 55.1 | 57.3 |
| Northern pike | 22.7 | 2.7 | 5.8 | 3.2 | 2.8 | 0.6 |
| Yellow perch | 0.0 | 7.8 | 7.8 | 9.2 | 17.8 | 17.0 |
| Anything | 13.0 | 5.9 | 0.0 | 17.2 | 10.8 | 10.1 |
| Black crappie | 0.0 | 0.0 | 0.0 | 3.7 | 13.6 | 15.0 |

Table 19. Estimated open-water angling hours by month (May - August) and totaled by year (1997 - 2001) and the estimated economic impact generated during these periods for Waubay Lake, South Dakota. For the years 1997 to 2000 two SE are provided in parentheses and 95% confidence intervals are provided for 2001 and 2002 angler hour estimates.

| | Estimated angler hours | | | | | |
|---|---|---|---|---|---|---|
| Year | May | June | July | August | Total | Economic value ($) |
| 1997 | 722<br>(280) | 2,919<br>(1,204) | 3,867<br>(2,010) | 19,451<br>(3,550) | 26,959<br>a | 470,215 |
| 1998 | 8,168<br>(3,517) | 10,837<br>(3,217) | 56,605<br>(13,815) | 42,154<br>(12,834) | 117,764<br>a | 1,635,611 |
| 1999 | 46,599<br>(8,524) | 82,541<br>(12,120) | 49,592<br>(8,110) | 81,496<br>(12,029) | 260,228<br>a | 3,424,053 |
| 2000 | 61,321<br>(12,787) | 47,938<br>(9,473) | 42,104<br>(6,740) | 23,163<br>(4,072) | 174,526<br>a | 2,469,708 |
| 2001 | 47,976<br>(35,597) | 28,458<br>(13,253) | 20,866<br>(8,633) | 14,422<br>(6,293) | 111,723<br>(39,458) | 1,551,708 |
| 2002 | 70,213<br>(28,906) | 36,206<br>(11,894) | 15,226<br>(6,639) | 18,114<br>(4,993) | 139,769<br>(32,344) | 1,871,906 |

a - total estimated angler hour SE could not be calculated with software

Table 20. Mean number of anglers per angling party and mean trip length (h) during May through August (1997 - 2002) for Waubay Lake, South Dakota.

| | May | | June | | July | | August | | Average | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Anglers | Trip | Anglers | Trip | Anglers | Trip | Anglers | Trip | Anglers | Trip |
| 1997 | 2.1 | 4.1 | 2.4 | 3.5 | 2.3 | 4.4 | 2.5 | 4.7 | 2.4 | 4.3 |
| 1998 | 2.4 | 4.4 | 2.3 | 5.1 | 2.6 | 5.6 | 2.3 | 5.6 | 2.4 | 5.4 |
| 1999 | 2.4 | 5.1 | 2.5 | 6.0 | 2.5 | 5.7 | 2.4 | 5.7 | 2.5 | 5.7 |
| 2000 | 2.4 | 5.6 | 2.6 | 5.3 | 2.4 | 5.2 | 2.4 | 4.9 | 2.5 | 5.3 |
| 2001 | 2.1 | 5.9 | 2.3 | 5.1 | 2.5 | 5.1 | 2.4 | 5.3 | 2.3 | 5.4 |
| 2002 | 2.4 | 5.6 | 2.5 | 5.1 | 2.6 | 4.4 | 2.5 | 5.8 | 2.4 | 5.6 |

Catch and Harvest

**Walleye**

Walleye harvest was greatest in 1999 when an estimated 81,759 walleyes were harvested during May through August (Table 21). In 1998, an estimated 41,172 walleyes were harvested (Table 21), but angling pressure was less than half of that observed in 1999 (Table 19). The catch and harvest rates per angler h fished were similar during 1998 and 1999 (Table 22). During both of these years the catch rate approximated 0.5 walleyes per h and the harvest rate exceeded 0.3 walleyes per h fished. Colby et al. (1979) indicated that a good walleye fishery exists when walleyes are caught at a rate of 0.3 per hour fished when anglers target all species. Without recruitment, the walleye population density was sufficiently reduced by anglers following 1998 and 1999 that walleye harvest did not exceed 20,000 walleyes during any year since 1999 (Table 21) and harvest rates have been less than 0.12 walleyes per h fished (Table 22).

The average harvested walleye size equaled or exceeded 406 mm TL during surveyed years (Figure 7). The 1997 and 1998 harvest was prior to enactment of the 406 mm (16 in) minimum-length limit. Harvest of sub-legal walleyes during open-water appears to have been minimal since enactment of the 406 mm minimum-length limit in October 1998.

**Northern Pike**

The percentage of anglers targeting northern pike decreased following 1997 (Table **18).** During the 2002 open-water period, less than 1 % of interviewed anglers indicated they were targeting northern pike. Although anglers typically do not target northern pike they have been common in the angler catch (Table 21). Open-water anglers harvested less than a third of the

northern pike caught from 1997 to 2002 (Table 21). The peak catch and harvest occurred in 1999 when an estimated 75,094 northern pike were caught and the harvest was 13,282 individuals. Anglers harvested a wide-length range of northern pike (Figure 8). Mean total lengths of harvested northern pike ranged from 611 (1998) to 669 mm (2001).

Catch and harvest rates were greatest in 1997 when the highest percent of anglers targeted northern pike (Table 22). From 1998 through 2000, overall catch rates remained relatively stable at 0.22 to 0.29 northern pike per h, but decreased to 0.1 and less in 2001 and 2002 (Table 22). Some of the decrease in catch rate may be attributable to the change in angler target species. In 2001 and 2002, an increased percent of anglers were targeting yellow perch and black crappies (Table 18) which may result in fewer northern pike being caught because of different angling techniques used.

**Yellow Perch**

Yellow perch were abundant in the angler catch and harvest during May through August 1998 to 2002 (Table 21). Few yellow perch were caught during 1997. The highest catch and harvest occurred in 1999 when the greatest amount of angling pressure was recorded (Table 19). In some years, a substantial amount of yellow perch harvest occurred in September and October when no survey was being completed.

Yellow perch catch rates since 1997 have been high with several monthly estimates exceeding one yellow perch per h fished (Table 22). In 1999, the catch rate for the entire summer was 1.25. Harvest rates for the entire summer following 1997 have fluctuated between 0.17 and 0.43 yellow perch per hour (Table 22). In August 2001, 1.24 yellow perch were harvested for every angler hour.

In general, open-water anglers began harvesting yellow perch at 180 mm (7 in) TL (Figure 9). Mean lengths of harvest yellow perch ranged from 230 to 248 mm.

**Black Crappie**

Anglers began to target black crappies in 1999 (Table 18) and the first quantifiable catches and harvest occurred in 1999 (Table 21). Since 1999, the catch and harvest have increased each year. In 2002, 15% of interviewed anglers indicated they were targeting black crappies (Table 18). Anglers harvested greater than 75% of the black crappies caught (Table 22). The greatest catch and harvest has occurred in May when approximately two thirds of the total catch and harvest take place (Table 21). Most of the angling activity for black crappies occurs on the north end of the lake. Shore angling opportunities exist when black crappies stage in this area.

Similar to yellow perch, anglers started harvesting black crappies at approximately 180 mm (7 in) TL (Figure 10). The mean length of harvested black crappies ranged from 256 to 289 mm with the size of harvested crappies increasing each year from 2000 to 2002. The size of angler harvested black crappies resembles what was collected during August frame netting (Figure 6).

Table 21. Estimated number of walleye, northern pike, yellow perch, and black crappies caught and harvested by month (May - August) and year (1997 - 2002) at Waubay Lake, South Dakota.

| Species | Year | May | | June | | July | | August | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Walleye | 1997 | 0 (-) | 0 (-) | 153 (227) | 82 (130) | 895 (687) | 457 (333) | 7,272 (2,712) | 3,301 (1,141) | 8,320 a | 3,840 a |
| | 1998 | 13,461 (16,109) | 4,736 (3,137) | 3,272 (1,434) | 1,782 (763) | 34,421 (10,108) | 25,471 (7,254) | 10,489 (3,742) | 9,183 (3,458) | 61,643 a | 41,172 a |
| | 1999 | 30,514 (7,688) | 21,412 (5,004) | 30,838 (6,093) | 21,191 (3,975) | 24,570 (5,096) | 16,717 (3,449) | 39,888 (9,577) | 22,481 (5,209) | 125,429 a | 81,759 a |
| | 2000 | 23,688 (6,981) | 9,375 (2,887) | 18,454 (6,180) | 3,497 (1,098) | 19,481 (4,675) | 5,726 (1,648) | 13,444 (6,580) | 1,363 (592) | 75,067 a | 19,961 a |
| | 2001 | 25,662 (24,210) | 5,209 (4,726) | 32,609 (19,431) | 2,247 (1,843) | 8,849 (5,804) | 750 (674) | 2,603 (1,661) | 160 (232) | 69,723 (31,625) | 8,366 (5,122) |
| | 2002 | 75,224 (35,093) | 5,512 (3,527) | 56,660 (24,310) | 1,888 (1,726) | 19,320 (9,290) | 478 (384) | 19,489 (9,596) | 543 (270) | 170,116 (44,588) | 8,404 (3,953) |
| Northern pike | 1997 | 6 (12) | 6 (12) | 1,773 (1,009) | 882 (543) | 1,698 (1,252) | 444 (311) | 8,213 (2,595) | 1,964 (846) | 11,690 a | *3,296* a |
| | 1998 | 3,948 (3,125) | 1,154 (880) | 2,494 (1,473) | 853 (1,075) | 13,038 (4,131) | 1,271 (612) | 9,209 (3,305) | 1,522 (766) | 28,689 a | 4,800 a |

Table 21. Continued.

| Species | Year | May | | June | | July | | August | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Northern pike | 1999 | 18,784 (5,987) | 5,206 (2,327) | 12,368 (3,216) | 2,098 (782) | 14,659 (3,801) | 1,792 (1,281) | 29,429 (10,184) | 4,168 (1,750) | 75,094 a | 13,282 a |
| | 2000 | 9,890 (4,732) | 1,980 (943) | 4,129 (2,422) | 1,570 (1,227) | 5,653 (1,821) | 700 (409) | 4,403 (2,013) | 666 (624) | 24,075 a | 4,916 a |
| | 2001 | 7,537 (6,698) | 2,519 (2,146) | 2,515 (1,469) | 571 (311) | 884 (723) | 177 (177) | 123 (100) | 54 (55) | 11,060 (6,896) | 3,321 (2,176) |
| | 2002 | 3,241 (1,822) | 807 (447) | 1,922 (1,008) | 656 (273) | 415 (247) | 43 (71) | 817 (370) | 73 (59) | 6,407 (2,126) | 1,569 (613) |
| Yellow perch | 1997 | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 4 (8) | 4 (8) | 111 (128) | 89 (113) | 115 a | 93 a |
| | 1998 | 83 (156) | 76 (155) | 540 (296) | 208 (156) | 12,397 (4,511) | 5,321 (1,996) | 38,415 (16,853) | 14,192 (6,425) | 51,435 a | 19,797 a |
| | 1999 | 25,904 (9,904) | 10,197 (7,625) | 121,858 (33,320) | 24,855 (9,615) | 65,151 (19,176) | 15,289 (8,185) | 115,248 (26,849) | 24,397 (9,353) | 325,403 a | 72,336 a |
| | 2000 | 24,876 (10,738) | 9,404 (5,023) | 43,636 (17,230) | 22,163 (9,570) | 59,446 (28,219) | 24,354 (12,504) | 21,711 (10,827) | 12,114 (7,617) | 149,669 a | 68,035 a |

Table 21. Continued.

| Species | Year | May | | June | | July | | August | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| | 2001 | 272 (253) | 117 (173) | 30,032 (28,708) | 17,271 (13,347) | 20,637 (10,757) | 12,240 (5,945) | 26,350 (14,994) | 17,932 (10,471) | 77,291 (34,128) | 47,561 (17,971) |
| | 2002 | 5,066 (2,583) | 3,488 (1,261) | 19,322 (9,066) | 14,835 (7,302) | 10,216 (5,811) | 6,555 (3,585) | 12,528 (2,700) | 9,414 (1,911) | 47,722 (6,299) | 34,932 (4,742) |
| Black crappie | 1997 | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) |
| | 1998 | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) |
| | 1999 | 0 (-) | 0 (-) | 418 (571) | 374 (567) | 79 (72) | 57 (56) | 522 (374) | 385 (289) | 1,019 a | 816 a |
| | 2000 | 3,455 (2,429) | 3,302 (2,412) | 1,265 (1,453) | 1,209 (1,447) | 312 (224) | 179 (165) | 179 (165) | 446 (288) | 5,891 a | 5,136 a |
| | 2001 | 12,536 (11,674) | 10,254 (8,791) | 5,227 (2,443) | 3,143 (1,521) | 302 (161) | 268 (163) | 304 (166) | 267 (128) | 18,368 (11,929) | 13,933 (8,924) |
| | 2002 | 13,659 (3,510) | 13,296 (3,488) | 6,642 (2,540) | 6,352 (2,434) | 104 (47) | 104 (47) | 186 (77) | 186 (77) | 20,542 (4,326) | 19,892 (4,221) |

a - software would not calculate a measure of dispersion for total

Table 22. Estimated overall angler catch and harvest rates (number/h) for walleye, northern pike, yellow perch and black crappie by month (May - August) and year (1997 - 2002) at Waubay Lake, South Dakota.

| Species | Year | May | | June | | July | | August | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Walleye | 1997 | 0.00 (-) | 0.00 (-) | 0.05 (0.07) | 0.03 (0.04) | 0.23 (0.13) | 0.12 (0.06) | 0.37 (0.12) | 0.17 (0.05) | 0.31 a | 0.14 a |
| | 1998 | 1.65 (1.84) | 0.58 (0.29) | 0.30 (0.10) | 0.16 (0.05) | 0.61 (0.10) | 0.45 (0.07) | 0.25 (0.05) | 0.22 (0.05) | 0.52 a | 0.35 a |
| | 1999 | 0.65 (0.11) | 0.46 (0.07) | 0.37 (0.05) | 0.26 (0.03) | 0.50 (0.06) | 0.34 (0.04) | 0.49 (0.09) | 0.28 (0.05) | 0.48 a | 0.31 a |
| | 2000 | 0.39 (0.08) | 0.15 (0.03) | 0.38 (0.10) | 0.07 (0.02) | 0.46 (0.08) | 0.14 (0.03) | 0.58 (0.27) | 0.06 (0.02) | 0.43 a | 0.11 a |
| | 2001 | 0.53 (0.91) | 0.11 (0.16) | 1.15 (1.26) | 0.08 (0.10) | 0.42 (0.49) | 0.04 (0.05) | 0.18 (0.30) | 0.01 (0.03) | 0.62 (0.51) | 0.07 (0.07) |
| | 2002 | 1.01 (0.75) | 0.08 (0.06) | 1.56 (1.11) | 0.05 (0.06) | 1.27 (1.07) | 0.03 (0.03) | 1.08 (0.76) | 0.03 (0.02) | 1.22 (0.50) | 0.06 (0.03) |
| Northern pike | 1997 | 0.01 (0.02) | 0.01 (0.02) | 0.61 (0.24) | 0.30 (0.14) | 0.44 (0.23) | 0.11 (0.05) | 0.42 (0.11) | 0.10 (0.04) | 0.44 a | 0.12 a |
| | 1998 | 0.48 (0.32) | 0.14 (0.09) | 0.23 (0.12) | 0.08 (0.10) | 0.23 (0.05) | 0.02 (0.01) | 0.22 (0.04) | 0.04 (0.01) | 0.24 a | 0.04 a |

Table 22. Continued.

| Species | Year | May | | June | | July | | August | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Northern pike | 1999 | 0.40 (0.11) | 0.11 (0.05) | 0.15 (0.03) | 0.03 (0.01) | 0.30 (0.06) | 0.04 (0.03) | 0.36 (0.11) | 0.05 (0.02) | 0.29 a | 0.05 a |
| | 2000 | 0.16 (0.07) | 0.03 (0.01) | 0.09 (0.05) | 0.03 (0.02) | 0.13 (0.04) | 0.02 (0.01) | 0.19 (0.08) | 0.03 (0.03) | 0.22 a | 0.04 a |
| | 2001 | 0.16 (0.27) | 0.05 (0.08) | 0.09 (0.10) | 0.02 (0.02) | 0.04 (0.06) | 0.01 (0.01) | 0.01 (0.02) | 0.00 (0.01) | 0.10 (0.10) | 0.03 (0.03) |
| | 2002 | 0.05 (0.06) | 0.01 (0.01) | 0.05 (0.04) | 0.02 (0.02) | 0.03 (0.03) | 0.00 (0.00) | 0.05 (0.02) | 0.00 (0.00) | 0.05 (0.02) | 0.01 (0.00) |
| Yellow perch | 1997 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.01 (0.01) | 0.00 (0.01) | 0.00 (0.00) | 0.00 (0.00) |
| | 1998 | 0.01 (0.02) | 0.01 (0.02) | 0.05 (0.02) | 0.02 (0.01) | 0.22 (0.06) | 0.09 (0.03) | 0.91 (0.29) | 0.34 (0.11) | 0.44 a | 0.17 a |
| | 1999 | 0.56 (0.19) | 0.22 (0.16) | 1.48 (0.34) | 0.30 (0.11) | 1.31 (0.32) | 0.31 (0.16) | 1.41 (0.25) | 0.30 (0.11) | 1.25 a | 0.28 a |
| | 2000 | 0.41 (0.15) | 0.15 (0.08) | 0.91 (0.31) | 0.46 (0.18) | 1.41 (0.63) | 0.58 (0.28) | 0.94 (0.44) | 0.52 (0.32) | 0.69 a | 0.43 a |
| | 2001 | 0.01 (0.01) | 0.00 (0.00) | 1.06 (1.37) | 0.61 (0.69) | 0.99 (0.96) | 0.59 (0.46) | 1.83 (2.34) | 1.24 (1.61) | 0.69 (0.46) | 0.43 (0.26) |

Table 22. Continued.

| Species | Year | May | | June | | July | | August | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Yellow perch | 2002 | 0.07 (0.05) | 0.05 (0.02) | 0.53 (0.35) | 0.41 (0.26) | 0.67 (0.63) | 0.43 (0.39) | 0.69 (0.25) | 0.52 (0.19) | 0.34 (0.07) | 0.25 (0.05) |
| Black crappie | 1997 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| | 1998 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| | 1999 | 0.00 (0.00) | 0.00 (0.00) | 0.01 (0.01) | 0.00 (0.01) | 0.00 (0.00) | 0.00 (0.00) | 0.01 (0.01) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| | 2000 | 0.06 (0.04) | 0.05 (0.04) | 0.03 (0.03) | 0.03 (0.03) | 0.01 (0.01) | 0.00 (0.00) | 0.04 (0.02) | 0.02 (0.01) | 0.00 (0.00) | 0.00 (0.00) |
| | 2001 | 0.26 (0.36) | 0.21 (0.28) | 0.18 (--) | 0.11 (--) | 0.01 (0.01) | 0.01 (0.01) | 0.02 (0.02) | 0.02 (0.02) | 0.17 (0.13) | 0.12 (0.10) |
| | 2002 | 0.19 (0.10) | 0.19 (0.09) | 0.18 (0.20) | 0.18 (0.19) | 0.01 (0.01) | 0.01 (0.01) | 0.01 (0.01) | 0.01 (0.01) | 0.15 (0.03) | 0.14 (0.03) |

a - software would not calculate a measure of dispersion for total

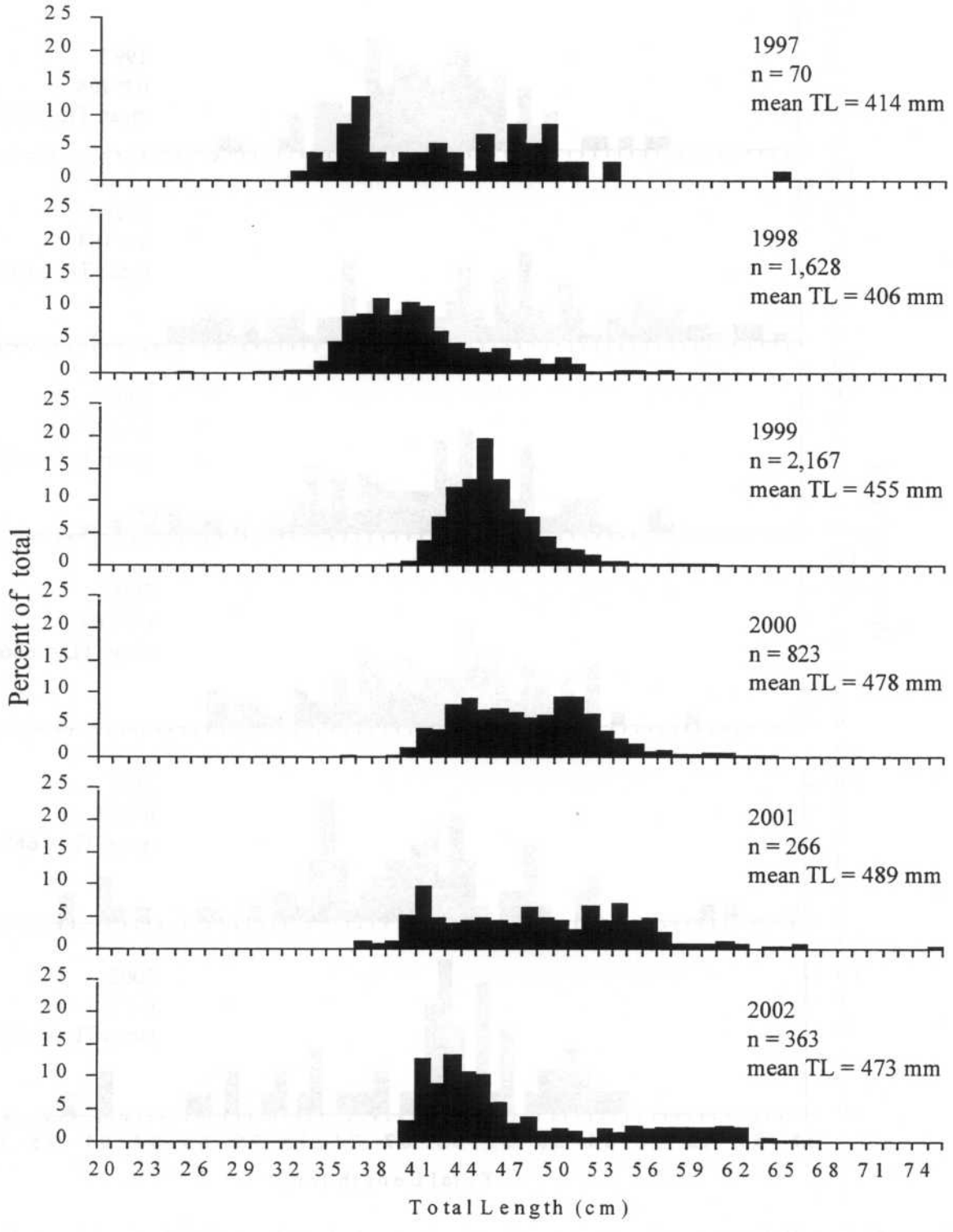


Figure 7. Length frequency histograms of angler harvested walleyes during May - August by year (1997-2002) for Waubay Lake, South Dakota, n is the number measured.

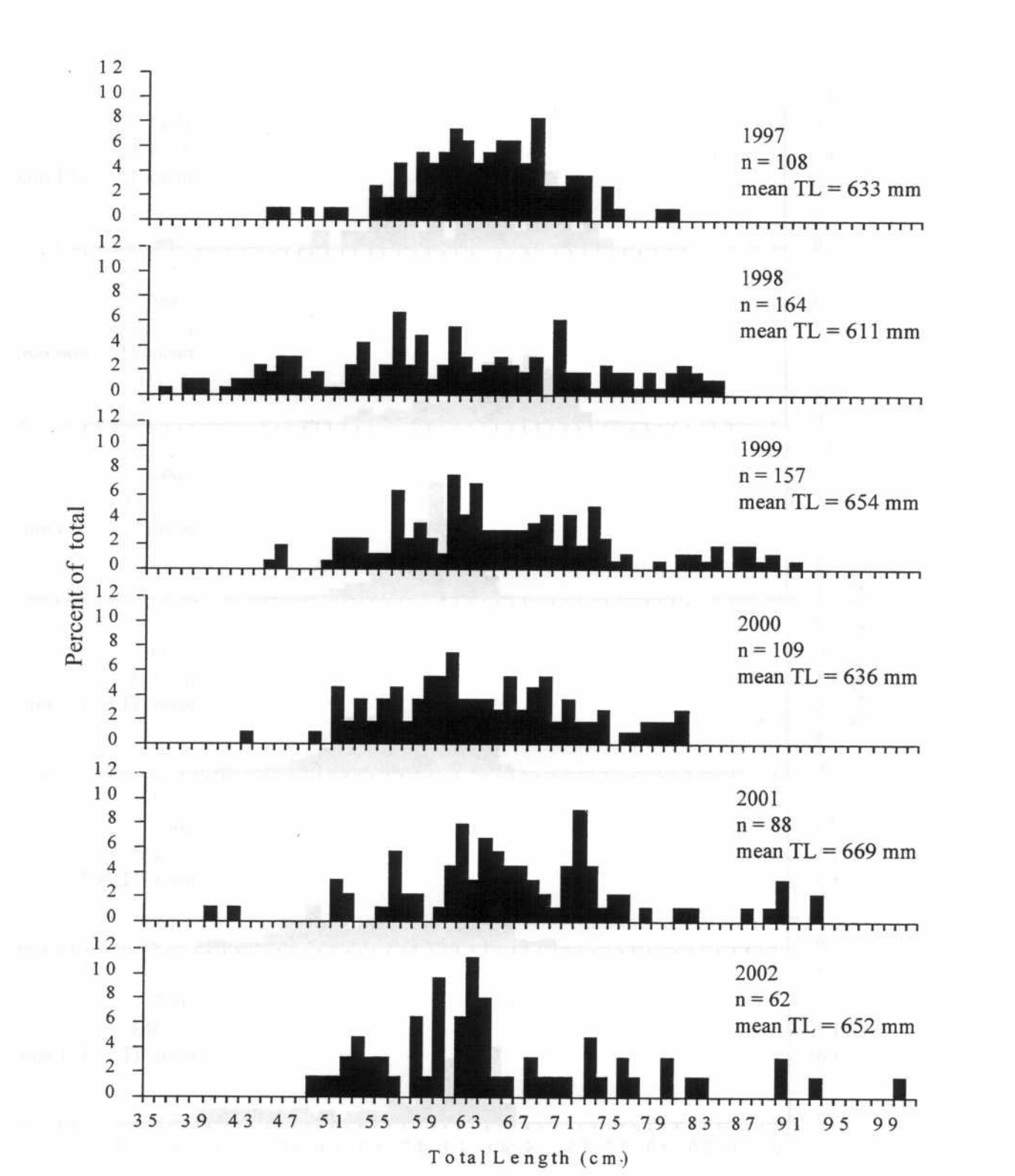


Figure 8. Length frequency histograms of angler harvested northern pike during May - August by year (1997-2002) for Waubay Lake, South Dakota, n is the number measured.

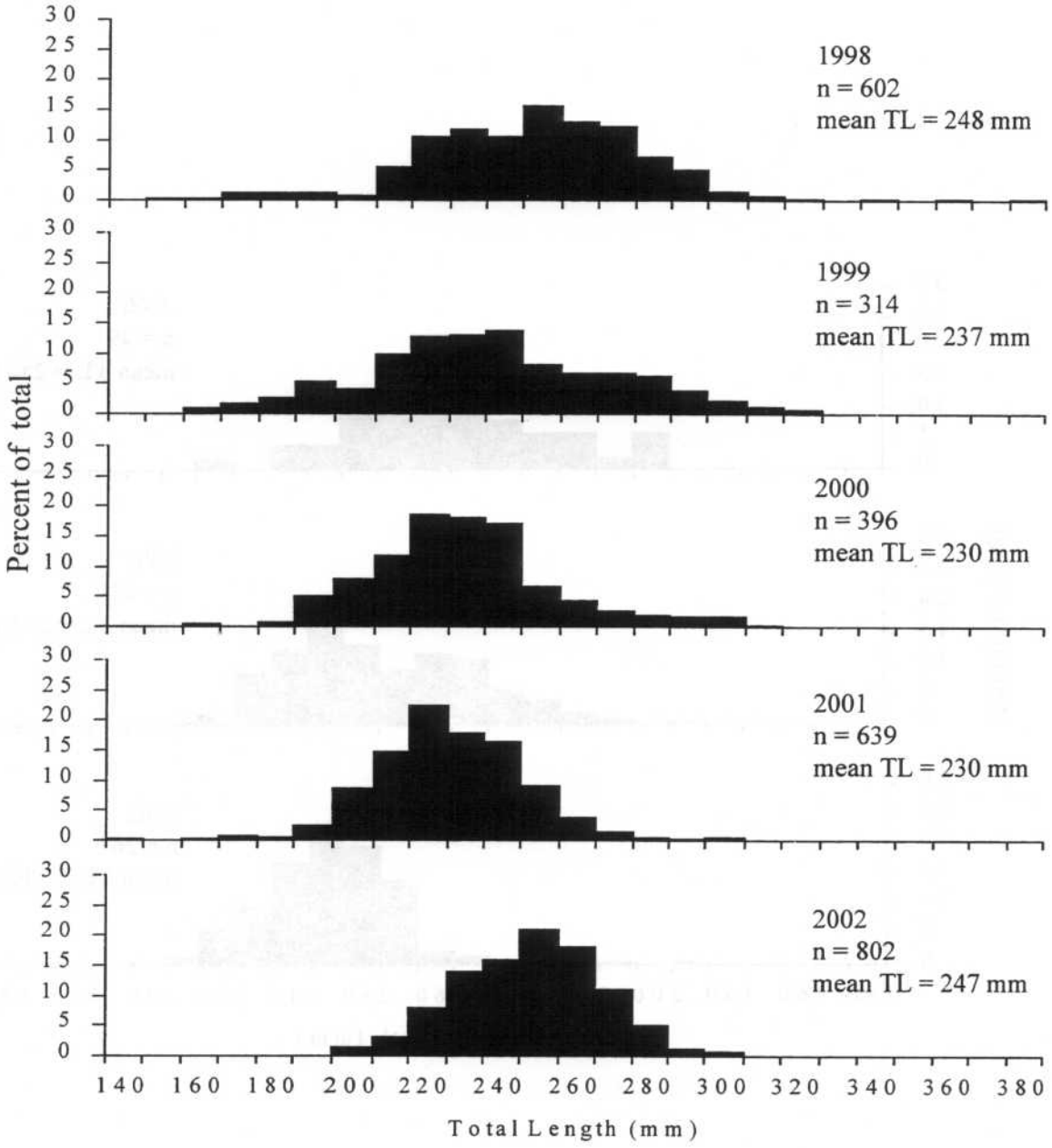


Figure 9. Length frequency histograms of angler harvested yellow perch during May - August by year (1998-2002) for Waubay Lake, South Dakota, n is the number measured.

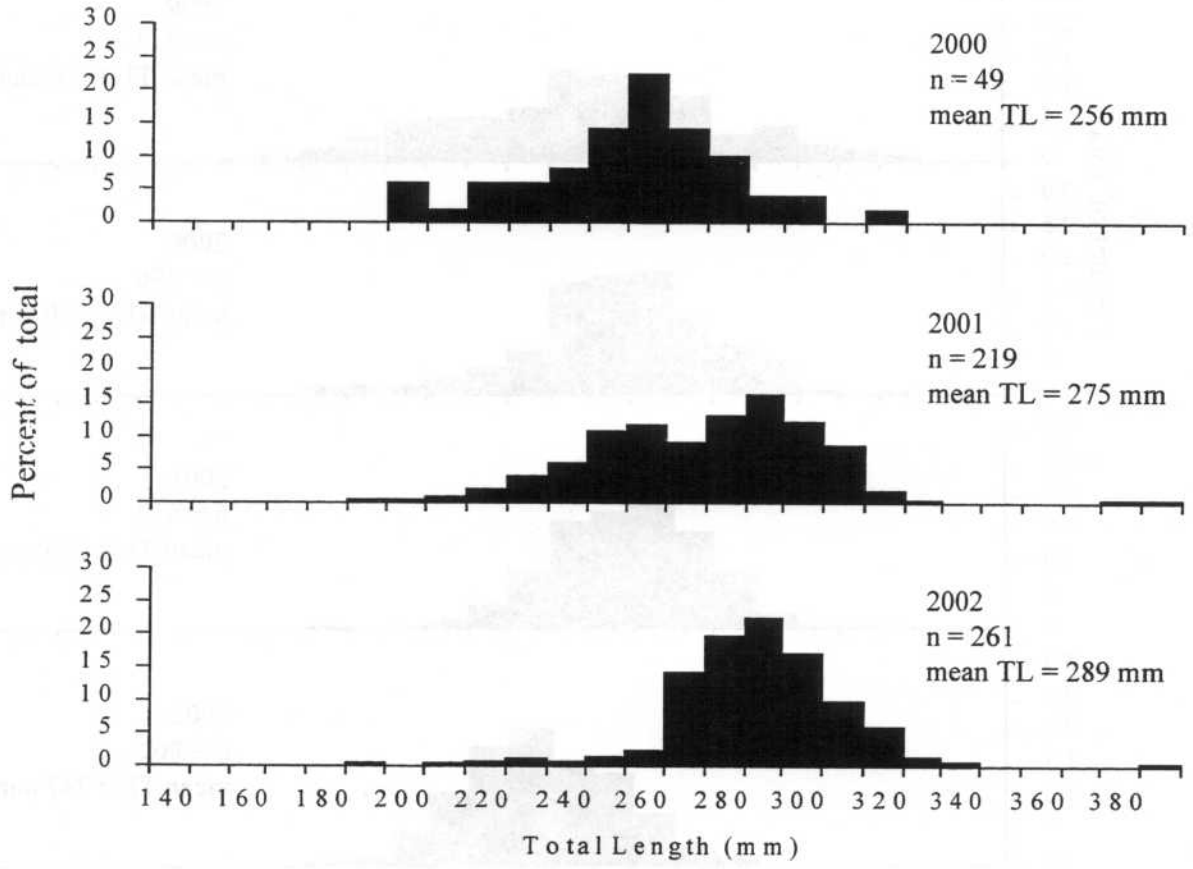


Figure 10. Length frequency histograms of angler harvested black crappies during May - August by year (2000 - 2002) for Waubay Lake, South Dakota, n is the number harvested.

## Angler Demographics and Economic Impact

From 1997 through 1999 resident anglers composed greater than 80% of the open-water anglers fishing Waubay Lake (Table 23). The percentage of nonresident anglers increased in 2000 and gradually increased each year thereafter. The increase in non-resident anglers in recent years is likely the result of the publicity Waubay Lake fishing has received. Prior to the publicity, only resident anglers were aware of the fishing at Waubay Lake.

In 1997, the majority of South Dakota resident anglers fishing Waubay during May through August were from Day County and immediate surrounding counties (Figure 11). Following 1997, the percentage of Day County anglers decreased as other Eastern South Dakota counties became represented. The percentage of anglers from Brown and Minnehaha counties showed the greatest increase from 1997 through 2002.

In addition to South Dakota, twenty-three states were represented during open-water angler interviews at Waubay Lake from 1997 to 2002 (Table 24). Minnesota, Iowa, Nebraska, and North Dakota represent the majority of non-resident anglers that fished Waubay Lake. Minnesota residents typically compose the bulk of non-resident anglers with number of Iowa anglers increasing in 2001 and 2002. The number of anglers from North Dakota peaked in 1999.

A shift in the one-way distance traveled to fish Waubay Lake during open-water periods occurred over the survey period. Following 1997, the percent of local angler (<25 miles travel) decreased from 30% to approximately 10% each year (1998 - 2002) (Table 25). From 1997 to 1999, over 75% of the anglers fishing Waubay Lake during open-water travel less than 100 miles, one way; however, from 2000 to 2002 approximately 50% of all anglers traveled 100 miles or less. During the period from 2000 to 2002, an increased percentage of anglers traveled in excess of 200 miles to fish Waubay Lake. This corresponds with changes in the percentages of resident and nonresident anglers during the survey period (Table 23).

The Waubay Lake open-water fishery from May through August had an estimated economic impact for local economies in excess of 11 million dollars from 1997 to 2002. In 1997, the economic impact was the lowest at an estimated $470,215 and the greatest impact occurred in 1999 at $3,424,053 (Table 19). The estimated economic impact is based on an average South Dakota daily angling expenditure of $75/day (U.S. Department of Interior, Fish and Wildlife Service, U.S. Department of Commerce Bureau of Census 1997).

## Angler Opinions

The 16-inch walleye minimum-length limit was implemented as a permanent rule in 1999. To gain information as to whether anglers were supportive of the regulation, in 1999 and 2000 anglers were asked if they supported the 16-inch minimum with one over 20 inches regulation. Greater than 93% were supportive of the new regulation in 1999, but in 2000 the percentage of anglers supporting the regulation decreased to 73% (Table 26). In 2000, almost

20% of the anglers had "no opinion" as to whether or not they supported the regulation while only 7% did not support the regulation.

Harvest is a component of the fishing experience. However, many South Dakota lakes cannot support the harvest that accompanies increased angling pressure. Implementation of harvest regulations is one way to reduce harvest, but education of anglers can also be used as a means for promoting "selective harvest." For selective harvest to work anglers need to be willing to release fish. We asked anglers how important harvesting fish was in deciding their angling satisfaction in 1998, 2000, and 2002. Each year, the greatest percentage of anglers indicated that harvesting fish was somewhat important (Table 27). The percent of anglers indicating that harvesting fish was very important ranged from 9.6 to 15.8 (Table 27). In 2002, 7.3% of anglers indicated that harvesting fish was the most important factor in defining a successful fishing trip (Table 28). Thus, a small percentage of anglers likely will only be happy if they can harvest everything that they catch, but it is encouraging that in excess of 55% of anglers indicated that harvesting fish was only somewhat to not important (Table 27).

Relaxation was the most frequent response to the question asking what the most important factor was in defining a successful fishing trip (Table 28). Anglers also indicated that being able to participate in fishing, catching fish, being with friends, and other personal reasons were important in their fishing success (Table 28).

In 1999 and 2001, anglers, when asked, were satisfied with their fishing at Waubay Lake. Satisfied anglers surpassed 80% in both years (Table 29). In addition, 87.6% of interviewed anglers indicated that they were satisfied in terms of catching the types of fish they were expecting and only 2.4% were dissatisfied (Table 30). The high level of satisfaction in 2001 is somewhat surprising since walleye (the primary target species) angling was reduced in 2001 when compared to 1999.

Anglers were asked whether they would be in favor of a smallmouth bass 15-inch minimum length limit on Northeast South Dakota lakes during interviews in 1998. Resulting responses showed that 49% would favor, 47% had no opinion, and 4% were against a smallmouth bass 15-inch minimum length. The high percentage of anglers with no opinion is not surprising since most anglers fishing Waubay Lake during open-water periods target walleyes.

Table 23. Monthly and overall percentage of resident (SD) and nonresident (non) anglers fishing from May through August (1997-2002) at Waubay Lake, South Dakota.

| | | Percentage (%) | | | | |
|---|---|---|---|---|---|---|
| Year | Res | May | June | July | August | Overall |
| 1997 | SD | 85.0 | 69.0 | 92.5 | 96.9 | 89.6 |
| | non | 15.0 | 31.0 | 7.5 | 3.1 | 10.4 |
| 1998 | SD | 83.7 | 86.9 | 87.0 | 83.7 | 85.3 |
| | non | 16.3 | 13.1 | 13.0 | 16.3 | 14.7 |
| 1999 | SD | 84.1 | 80.2 | 84.8 | 83.5 | 82.8 |
| | non | 15.9 | 19.8 | 13.2 | 16.5 | 17.2 |
| 2000 | SD | 58.0 | 68.2 | 68.4 | 67.9 | 65.0 |
| | non | 42.0 | 31.8 | 31.6 | 32.1 | 35.0 |
| 2001 | SD | 65.9 | 56.0 | 72.2 | 57.8 | 63.3 |
| | non | 34.1 | 44.0 | 27.8 | 42.2 | 36.7 |
| 2002 | SD | 59.8 | 50.0 | 65.6 | 69.0 | 59.5 |
| | non | 40.2 | 50.0 | 34.4 | 21.0 | 40.5 |

Table 24. Percent of nonresident anglers from various states that fished from May through August of 1997 to 2002 at Waubay Lake, South Dakota.

| | Percentage (%) | | | | | |
|---|---|---|---|---|---|---|
| State | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| Arizona | 0.00 | 0.00 | 0.39 | 0.87 | 0.00 | 0.78 |
| California | 0.00 | 0.00 | 1.18 | 0.00 | 0.00 | 0.00 |
| Colorado | 0.00 | 0.00 | 0.00 | 1.31 | 1.48 | 1.17 |
| Florida | 0.00 | 0.00 | 0.00 | 0.87 | 0.00 | 0.00 |
| Georgia | 0.00 | 0.00 | 0.00 | 0.44 | 0.00 | 0.00 |
| Illinois | 0.00 | 1.05 | 0.00 | 0.44 | 2.22 | 1.56 |
| Indiana | 4.35 | 0.00 | 0.00 | 0.44 | 0.00 | 0.39 |
| Iowa | 13.04 | 14.74 | 11.76 | 35.37 | 34.81 | 35.55 |
| Kansas | 4.35 | 0.00 | 0.00 | 0.44 | 0.00 | 1.56 |
| Louisiana | 0.00 | 0.00 | 0.00 | 0.44 | 0.00 | 0.00 |
| Minnesota | 39.13 | 36.84 | 42.75 | 36.24 | 36.30 | 39.45 |
| Missouri | 0.00 | 0.00 | 0.78 | 1.31 | 0.00 | 1.56 |
| Nebraska | 30.43 | 7.37 | 2.35 | 5.68 | 5.19 | 5.47 |
| New Mexico | 0.00 | 0.00 | 0.39 | 0.00 | 0.00 | 0.00 |
| Nevada | 0.00 | 1.05 | 0.00 | 0.00 | 0.00 | 0.39 |
| North Dakota | 4.35 | 30.53 | 39.61 | 10.92 | 11.85 | 6.64 |
| Ohio | 0.00 | 0.00 | 0.00 | 0.00 | 0.74 | 0.00 |
| Oklahoma | 0.00 | 0.00 | 0.39 | 0.44 | 0.00 | 0.00 |
| Oregon | 0.00 | 4.21 | 0.00 | 0.87 | 0.00 | 0.39 |
| Texas | 0.00 | 0.00 | 0.00 | 0.00 | 0.74 | 0.39 |
| Washington | 0.00 | 1.05 | 0.00 | 0.00 | 0.00 | 0.00 |
| Wisconsin | 0.00 | 3.16 | 0.00 | 3.49 | 6.67 | 3.52 |
| Wyoming | 4.35 | 0.00 | 0.39 | 0.44 | 0.00 | 1.17 |

Table 25. Percent of anglers traveling the specified distances (miles), one way, to fish Waubay Lake, South Dakota, during May through August of 1997 through 2002.

| Distance (miles) | Percent (%) by year | | | | | |
|---|---|---|---|---|---|---|
| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| <25 | 30.4 | 9.8 | 12.0 | 10.5 | 8.9 | 9.1 |
| 25-50 | 23.0 | 13.3 | 16.8 | 17.9 | 23.5 | 11.9 |
| 51-100 | 33.0 | 59.2 | 50.0 | 28.1 | 25.5 | 29.1 |
| 101-200 | 6.1 | 10.2 | 16.7 | 19.6 | 18.1 | 20.1 |
| >200 | 7.4 | 7.5 | 4.5 | 23.9 | 24.0 | 29.9 |

Table 26. Angler responses in 1999 and 2000 to the question: "Are you supportive of the walleye harvest regulations for this lake?" n is the number of responses.

| Response | Percentage (%) | |
|---|---|---|
| | 1999 (n=989) | 2000 *(n=259)* |
| Yes | 93.5 | 73.0 |
| No | 0.9 | 7.3 |
| No opinion | 5.6 | 19.7 |

Table 27. Angler responses in 1998, 2000, and 2002 to the question: "How important would you rate harvesting fish in your angling satisfaction (i.e. do you need to harvest fish to have a successful fishing trip)?" n is the number of responses.

| | Percentage (%) | | |
|---|---|---|---|
| Response | 1998 (n=440) | 2000 (n=260) | 2002 (n=512) |
| Not Important | 13.6 | 27.3 | 23.1 |
| Somewhat important | 41.6 | 35.0 | 45.9 |
| Important | 33.6 | 28.1 | 15.2 |
| Very Important | 11.1 | 9.6 | 15.8 |

Table 28. Angler responses in 2002 to the question: "What is the most important factor to you in defining a successful fishing trip?" n is the number of responses.

| | Percentage (%) |
|---|---|
| Response | 2002 (n=509) |
| Relaxation | 33.6 |
| Harvesting fish | 7.3 |
| Participating | 13.6 |
| Catching fish | 15.3 |
| Being with friends | 13.8 |
| Other | 16.5 |

Table 29. Angler responses in 1999 and 2001 to the question: "Considering all factors, how satisfied are you with your fishing trip today?" n is the number of responses.

| | Percentage (%) | |
|---|---|---|
| Response | 1999 (n=999) | 2001 (n=289) |
| Satisfied | 80.4 | 86.9 |
| Neutral | 11.3 | 4.5 |
| Dissatisfied | 8.3 | 8.7 |

Table 30. Angler responses in 2001 to the question: "How would you rate your fishing trip in terms of catching the types of fish you were expecting?" n is the number of responses.

| | Percent (%) |
|---|---|
| Response | 2001 (n=291) |
| Satisfied | 87.6 |
| Neutral | 10.0 |
| Dissatisfied | 2.4 |

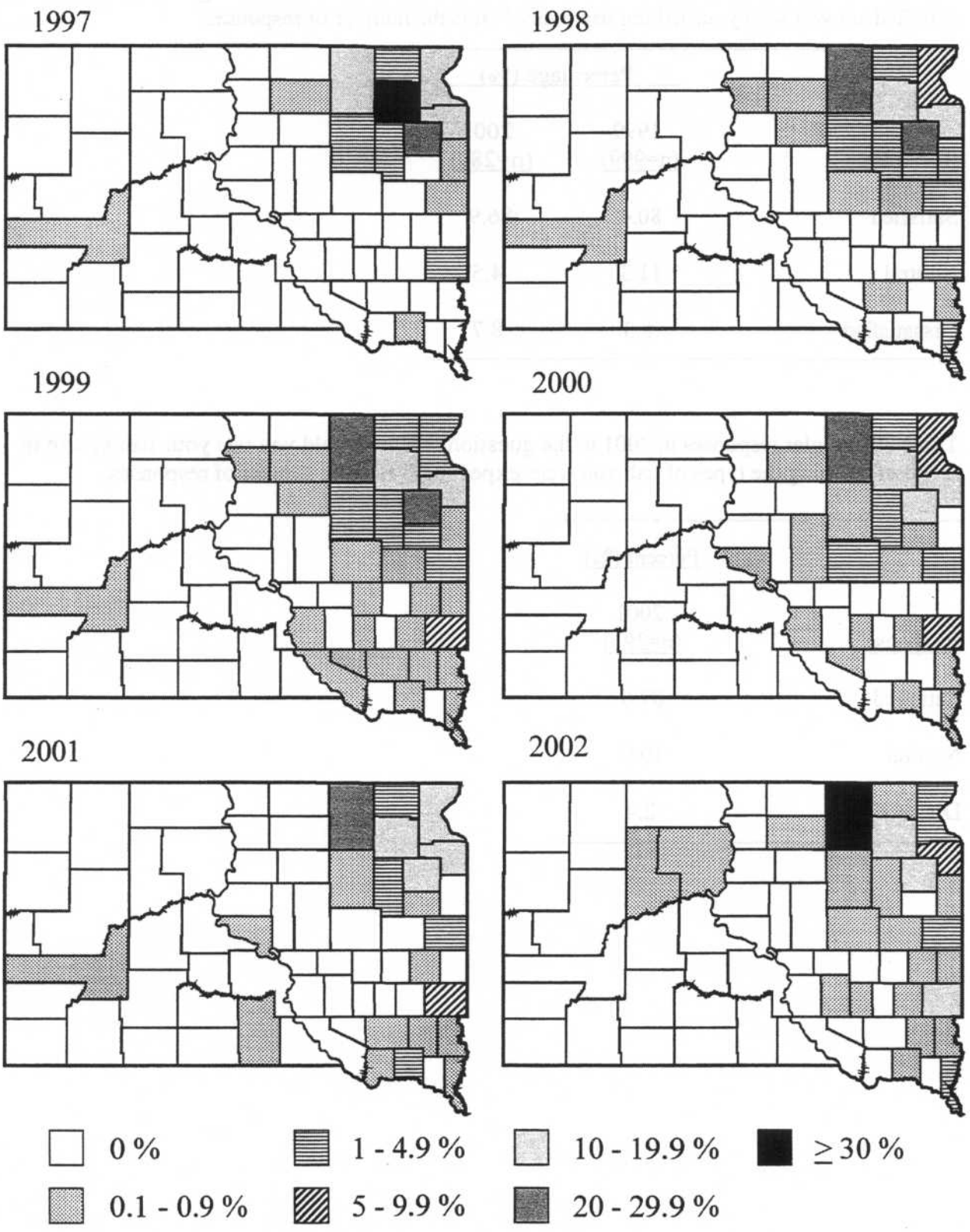


Figure 11. South Dakota county of residence for open-water resident anglers fishing Waubay Lake, South Dakota during May through August of 1997 to 2002 (May - August).

*Winter Ice Angling*

Fishing Pressure

The winter fishery differs from the open-water fishery in that few anglers target walleyes while fishing through the ice. The greatest percentage of anglers targeting walleye (15.2%) occurred during the 1999-00 winter (Table 31). Aside from 1996-97 and 1999-00 winters, approximately 6% of the anglers fishing Waubay targeted walleyes each winter. During the 1996-97 winter 96.2% of interviewed anglers were targeting northern pike and the remaining 3.8% indicated they were targeting any species (Table 31). The percentage of anglers targeting northern pike decreased to 36.4% in 1997-98 winter and fell below 20% in subsequent winters (Table 31). Yellow perch were the most sought after species following the 1996-97 winter (Table 31). The percent of anglers targeting yellow perch ranged from 49.4 to 76.9%.

Fishing pressure during the 1996-97 winter was relatively low primarily because deep snow prevented lake access. Pressure increased during the 1997-98 winter, but not to the extent that occurred in subsequent years (Table 32). Total angler hours exceed 80,000 each winter from 1998-99 through 2001-02 with the greatest pressure (115,486 h) recorded during the 2001-02 winter (Table 32). On a monthly basis, December tends to have the least pressure likely because ice conditions rarely allow for vehicular traffic during the entire month (Table 32).

Similar to open-water angling at Waubay Lake the average party size approximated two anglers during all periods with the exception of the 1997-98 winter (Table 33). During the 1997-98 winter all anglers were interviewed separately resulting in a mean party size of 1.0 anglers. Average overall trip lengths ranged from 5.2 h to 3.8 h while the monthly low was 3.1 h in December 2001 and the high was 6.1 h in February 1997 (Table 33).

Table 31. Primary target species by anglers fishing Waubay Lake, South Dakota during winter months December 1996 through March 2002

| | Percentage (%) | | | | | |
|---|---|---|---|---|---|---|
| Target Species | 1996-97 | 1997-98 | 1998-99 | 1999-00 | 2000-01 | 2001-02 |
| Walleye | 0.0 | 5.5 | 6.8 | 15.2 | 6.0 | 6.3 |
| Northern pike | 96.2 | 36.4 | 6.2 | 19.5 | 14.8 | 6.9 |
| Yellow perch | 0.0 | 57.8 | 71.3 | 49.4 | 54.3 | 76.9 |
| Anything | 3.8 | 0.3 | 15.7 | 15.9 | 24.2 | 9.9 |
| Black crappie | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 |

Table 32. Estimated winter fishing pressure (December - March) by month and year (1996 - 2002) and estimated economic benefit for Waubay Lake, South Dakota. For surveys prior to 2001-02 two SE are provided in parentheses and 95% confidence intervals are provided for 2001-02 estimates.

| | Estimated angler hours | | | | | Economic |
|---|---|---|---|---|---|---|
| Years | December | January | February | March | Total | value ($) |
| 1996-97 | 582<br>(184) | 1,055<br>(128) | 1,491<br>(451) | 2,762<br>(951) | 5,890<br>a | 84,952 |
| 1997-98 | 3,221<br>(1,004) | 8,809<br>(1,375) | 7,905<br>(2,625) | b | 19,935<br>a | 299,025 |
| 1998-99 | 8,499<br>(2,877) | 22,444<br>(6,232) | 51,021<br>(11,086) | 9,094<br>(1,515) | 91,058<br>a | 1,626,036 |
| 1999-00 | 6,416<br>(2,353) | 29,032<br>(3,588) | 33,713<br>(4,946) | 13,011<br>(2,298) | 82,172<br>a | 1,400,659 |
| 2000-01 | 8,682<br>(2,377) | *26,739*<br>(7,598) | 11,692<br>(3,321) | 34,056<br>(7,195) | 81,169<br>a | 1,323,408 |
| 2001-02 | 20,421<br>(14,663) | 39,615<br>(9,129) | 37,209<br>(17,331) | 18,223<br>(5,535) | 115,486<br>a | 2,279,329 |

a - Total estimated angler hour SE could not be calculated with software
b - survey not completed in March 1998

Table 33. Mean number of anglers per angling party and mean trip length during December through March (1996 - 2002) for Waubay Lake, South Dakota.

| | December | | January | | February | | March | | Average | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Anglers | Trip | Anglers | Trip | Anglers | Trip | Anglers | Trip | Anglers | Trip |
| 1996-97 | 2.3 | 4.1 | 2.3 | 2.4 | 2.1 | 6.1 | 3.0 | 6.0 | 2.4 | 5.2 |
| 1997-98 | 1.0 | 4.4 | 1.0 | 4.5 | 1.0 | 5.5 | | | 1.0 | 5.0 |
| 1998-99 | 2.1 | 5.0 | 1.8 | 2.6 | 2.1 | 4.9 | 1.7 | 4.7 | 1.9 | 4.2 |
| 1999-00 | 2.2 | 4.7 | 2.0 | 3.4 | 2.2 | 4.9 | 2.1 | 4.6 | 2.5 | 4.4 |
| 2000-01 | 2.2 | 3.6 | 2.1 | 4.2 | 2.7 | 4.0 | 2.5 | 5.5 | 2.3 | 4.6 |
| 2001-02 | 2.2 | 3.1 | 1.9 | 4.0 | 2.0 | 4.1 | 1.9 | 4.1 | 2.0 | 3.8 |

Catch and Harvest

**Walleye**

Fewer than 10,000 walleyes were caught during each of the first four winter creel periods (Table 34). Walleye catches increased substantially during the winters of 2000-01 and 2001-02, but harvest did not. The high walleye catches during these two winters were the result of the large 1999 walleye year-class. Because the 1999 year class was less than 16 inches, the angler walleye harvest did not increase. In general, walleye catch and harvest rates were lower than those experienced by open-water anglers.

The length distribution of winter harvested walleyes was similar to that during the summer. Mean lengths of angler harvested walleyes ranged from 378 mm to 493 mm (Figure 12). Prior to enactment of the 16-inch minimum-length limit anglers began harvesting walleyes at 220 mm. Since the beginning of the 16-inch minimum, a percentage of the winter walleye harvest has been composed of sub-legal walleyes. Because winter walleye fishing tends to be more difficult than open-water angling at Waubay Lake anglers may become frustrated and more willing to break the law.

**Northern Pike**

Northern pike were a substantial component of the winter fishery on Waubay Lake during the survey period. Winter anglers appear to be more willing to harvest northern pike than open-water anglers. Anglers harvested in excess of 50% of the northern pike caught during all winter surveys (Table 34); whereas, during the summer less than a third of all caught pike were harvested.

No differences were apparent in the length distributions of winter harvest northern pike and those that were harvested during open-water periods. Mean lengths of harvested northern pike ranged from 611 to 669 mm (Figure 13). The lengths of harvested northern pike encompass a wide range likely indicative of several northern pike age classes.

Northern pike catch rates were greatest during the 1996-97 winter and lowest in 2001-02 (Table 35). The highest monthly catch rate was recorded during March 1999 when anglers caught 0.91 northern pike per hour fished. It is probable that because April is not included in our standard survey that we miss a substantial component of the northern pike catch and harvest.

**Yellow Perch**

Yellow perch were the most sought species during all winter periods with the exception of 1996-97 (Table 31). Since the 1998-99 winter, yellow perch catch has exceeded 90,000 and approximated or surpassed 200,000 during three winters (Table 34). During these winters the harvest exceeded 85,000 yellow perch and the highest recorded harvest occurred during 2001-02 when an estimated 148,062 perch were harvested (Table 34).

Yellow perch catch rates have been relatively high since the 1998-99 winter (Table 34). The greatest catch rate occurred across the 1998-99 winter when 2.44 yellow perch were caught for every angler hour for every hour and lowest catch rate occurred in 2000-01 when 1.35 perch were caught per angler hour. The corresponding harvest during this time period ranged from 0.94 to 1.47 yellow perch per angler hour. At Reetz Lake, South Dakota during the 2001-02 winter anglers had a yellow perch catch rate of 2.2 perch per hour and a harvest rate of 0.7 fish per hour (unpublished information). The yellow perch population in Reetz Lake represented a relatively unexploited population. Although the catch and harvest of yellow perch have remained high since 1998 reductions can be expected following the 2002-03 winter because of several years of poor recruitment.

The percent of anglers harvesting a 25 fish yellow perch limit ranged from 1.2 to 10.3% during the winters of 1998-99 through 2000-01 (Table 36). During the same periods greater than 70% of anglers harvested 10 or fewer yellow perch per angling trip. Cook et al. (2001) indicated that less than 5% of Minnesota angler trips result in the harvest of a daily limit and that high creel limits might cause anglers to have unrealistic expectations that are not met resulting in dissatisfied anglers. In the 2001-02 winter, 32.4% of anglers harvested 10 yellow perch (Table 36); the yellow perch limit had been reduced to 10 perch prior to the 2001-02 winter. Because of the good fishing during the 2001-02 winter and the 10 fish yellow perch limit an increased percentage of anglers were able to harvest a limit during the 2001-02 winter.

Table 34. Estimated number of walleye, northern pike, yellow perch, and black crappies caught and harvested by month (December - March) and year (1996 - 2002) at Waubay Lake, South Dakota.

| Species | Year | December | | January | | February | | March | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Walleye | 96-97 | 0 (0.0) | 0 (0.0) | 58 (48) | 45 (41) | 7 (10) | 5 (9) | 30 (46) | 30 (46) | 95 a | 80 a |
| | 97-98 | 136 (89) | 120 (82) | 635 (328) | 508 (255) | 2,680 (1,497) | 1,472 (855) | -- | -- | 3,451 a | 2,100 a |
| | 98-99 | 654 (387) | 503 (302) | 2,961 (1,896) | 1,027 (469) | 2,695 (894) | 2,285 (778) | 2,128 (1,091) | 1,920 (965) | 8,438 a | 5,735 a |
| | 99-00 | 695 (476) | 374 (254) | 3,408 (2,363) | 1,027 (782) | 4,891 (2,247) | 1,455 (590) | 804 (444) | 645 (418) | 9,798 a | 3,501 a |
| | 00-01 | 2,512 (1,298) | 352 (276) | 9,529 (5,301) | 548 (382) | 4,751 (2,157) | 67 (70) | 10,212 (5,657) | 246 (243) | 27,004 a | 1,213 a |
| | 01-02 | 2,471 (2,085) | 104 (93) | 8,613 (5,027) | 228 (202) | 23,180 (14,365) | 896 (846) | 14,080 (10,387) | 577 (208) | 48,344 | 1,805 |
| Northern pike | 96-97 | 278 (176) | 277 (176) | 325 (161) | 325 (161) | 425 (180) | 414 (176) | 920 (449) | 913 (448) | 1,948 a | 1,929 a |
| | 97-98 | 2,384 (1,007) | 2,173 (890) | 1,909 (550) | 1,711 (533) | 3,049 (1,168) | 2,891 (1,108) | -- | -- | 7,342 a | 6,775 a |

Table 34. Continued.

| Species | Year | December | | January | | February | | March | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Northern pike | 98-99 | 542 (271) | 271 (190) | 2,147 (884) | 1,225 (583) | 3,932 (1,334) | 2,145 (861) | 3,474 (1,123) | 2,540 (947) | 10,095 a | 6,181 a |
| | 99-00 | 1,145 (619) | 687 (449) | 4,397 (1,224) | 3,085 (1,172) | 4,243 (1,216) | 3,229 (1,078) | 11,779 (3,109) | 5,595 (1,707) | 21,564 a | 12,596 a |
| | 00-01 | 2,544 (1,025) | 1,268 (651) | 5,938 (2,215) | 3,595 (1,394) | 1,945 (862) | 1,260 (577) | 5,429 (1,606) | 3,602 (1,200) | 15,856 a | 9,725 a |
| | 01-02 | 2,059 (1,628) | 1,739 (1,055) | 1,684 (269) | 1,368 (277) | 1,157 (966) | 846 (723) | 1,871 (1,402) | 1,485 (1,109) | 6,771 | 5,438 |
| Yellow perch | 96-97 | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 2 (5) | 2 (5) | 0 (0) | 0 (0) | 2 a | 2 a |
| | 97-98 | 2,384 (1,007) | 2,173 (890) | 2,893 (957) | 2,624 (841) | 3,049 (1,168) | 2,891 (1,108) | | | 8,326 a | 7,688 a |
| | 98-99 | 14,035 (5,411) | 8,430 (3,463) | 77,216 (27,958) | 20,189 (6,771) | 115,174 (28,219) | 51,381 (12,898) | 5,410 (1,682) | 12,128 (3,959) | 211,835 a | 92,128 a |
| | 99-00 | 8,701 (4,089) | 6,332 (3,167) | 84,595 (19,314) | 50,850 (13,141) | 103,650 (22,283) | 62,536 (14,290) | 2,849 (3,405) | 1,434 (1,307) | 199,795 a | 121,152 a |
| | 00-01 | 2,348 (1,177) | 1,381 (741) | 22,022 (7,693) | 18,145 (6,147) | 20,093 (7,593) | 14,087 (5,236) | 65,364 (19,600) | 52,754 (16,171) | 91,827 a | 86,367 a |

Table 34. Continued.

| Species | Year | December | | January | | February | | March | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Yellow perch | 01-02 | 38,332 (15,597) | 25703 (12,629) | 52,369 (29,129) | 40,346 (17,634) | 84,106 (55,879) | 59,427 (44,438) | 29,007 (42,381) | 22,586 (41,491) | 203,815 (75,941) | 148,062 (63,303) |
| Black crappie | 96-97 | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 a | 0 a |
| | 97-98 | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | -- | -- | 0 a | 0 a |
| | 98-99 | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 a | 0 a |
| | 99-00 | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 a | 0 a |
| | 00-01 | 0 (-) | 0 (-) | 42 (43) | 42 (43) | 36 (48) | 15 *(22)* | 459 *(515)* | 451 (512) | 537 a | 508 a |
| | 01-02 | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 0 (-) | 94 (130) | 94 (130) | 94 a | 94 a |

a - software would not calculate a measure of dispersion for total

Table 35. Estimated overall angler catch and harvest rates (number/h) for walleye, northern pike, yellow perch and black crappie by month (December - March) and year (1996 - 2002) at Waubay, South Dakota.

| Species | Year | December | | January | | February | | March | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Walleye | 96-97 | 0.00 (--) | 0.00 (--) | 0.05 (0.04) | 0.04 (0.04) | 0.00 (0.01) | 0.00 (0.01) | 0.01 (0.02) | 0.01 (0.02) | 0.02 a | 0.01 a |
| | 97-98 | 0.04 (0.02) | 0.04 (0.02) | 0.07 (0.04) | 0.06 (0.03) | 0.34 (0.15) | 0.19 (0.09) | -- -- | -- -- | 0.17 a | 0.11 a |
| | 98-99 | 0.08 (0.04) | 0.06 (0.03) | 0.13 (0.08) | 0.05 (0.02) | 0.04 (0.01) | 0.05 (0.01) | 0.23 (0.11) | 0.21 (0.10) | 0.09 a | 0.06 a |
| | 99-00 | 0.11 (0.06) | 0.06 (0.03) | 0.12 (0.08) | 0.04 (0.03) | 0.15 (0.06) | 0.04 (0.02) | 0.06 (0.03) | 0.05 (0.03) | 0.12 a | 0.04 a |
| | 00-01 | 0.29 (0.13) | 0.04 (0.03) | 0.36 (0.17) | 0.02 (0.01) | 0.41 (0.14) | 0.01 (0.01) | 0.30 (0.15) | 0.01 (0.01) | 0.33 a | 0.01 a |
| | 01-02 | 0.12 (0.13) | 0.01 (0.01) | 0.22 (0.12) | 0.01 (0.00) | 0.62 (0.69) | 0.02 (0.03) | 0.77 (0.75) | 0.03 (0.05) | 0.42 a | 0.02 a |
| Northern pike | 96-97 | 0.48 (0.26) | 0.48 (0.26) | 0.31 (0.15) | 0.31 (0.15) | 0.29 (0.08) | 0.28 (0.08) | 0.33 (0.12) | 0.33 (0.12) | 0.33 a | 0.33 a |
| | 97-98 | 0.11 (0.05) | 0.08 (0.04) | 0.22 (0.05) | 0.19 (0.05) | 0.15 (0.04) | 0.13 (0.03) | -- -- | -- -- | 0.17 a | 0.15 a |

Table 35. Continued.

| Species | Year | December | | January | | February | | March | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Northern pike | 98-99 | 0.06 (0.02) | 0.03 (0.02) | 0.10 (0.03) | 0.05 (0.02) | 0.08 (0.02) | 0.04 (0.01) | 0.38 (0.11) | 0.28 (0.09) | 0.11 a | 0.07 a |
| | 99-00 | 0.18 (0.07) | 0.11 (0.06) | 0.15 (0.04) | 0.11 (0.04) | 0.13 (0.03) | 0.10 (0.03) | 0.91 (0.18) | 0.43 (0.11) | 0.26 a | 0.15 a |
| | 00-01 | 0.29 (0.09) | 0.15 (0.03) | 0.22 (0.17) | 0.13 (0.01) | 0.17 (0.14) | 0.11 (0.01) | 0.16 (0.15) | 0.11 (0.01) | 0.20 a | 0.12 a |
| | 01-02 | 0.10 (0.19) | 0.09 (0.17) | 0.04 (0.03) | 0.03 (0.03) | 0.03 (0.04) | 0.02 (0.03) | 0.10 (0.10) | 0.08 (0.08) | 0.06 a | 0.05 a |
| Yellow perch | 96-97 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 a | 0.00 a |
| | 97-98 | 0.74 (0.05) | 0.67 (0.04) | 0.33 (0.05) | 0.30 (0.05) | 0.39 (0.04) | 0.37 (0.03) | -- -- | -- -- | 0.42 a | 0.39 a |
| | 98-99 | 1.65 (0.30) | 0.99 (0.23) | 3.44 (0.80) | 0.99 (0.17) | 2.26 (0.26) | 1.01 (0.13) | 1.33 (0.37) | 0.59 (0.16) | 2.44 a | 0.94 a |
| | 99-00 | 1.36 (0.07) | 0.99 (0.06) | 2.91 (0.04) | 1.75 (0.04) | 3.07 (0.03) | 1.85 (0.03) | 0.22 (0.18) | 0.11 (0.11) | 2.43 a | 1.47 a |
| | 00-01 | 0.27 (0.09) | 0.16 (0.03) | 0.82 (0.17) | 0.68 (0.01) | 1.72 (0.14) | 1.20 (0.01) | 1.92 (0.15) | 1.55 (0.01) | 1.35 a | 1.06 a |

Table 35. Continued.

| Species | Year | December | | January | | February | | March | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | catch | harvest | catch | harvest | catch | harvest | catch | harvest | catch | harvest |
| Black crappie | 01-02 | 1.88 (1.87) | 1.26 (1.37) | 1.32 (0.75) | 1.02 (0.49) | 2.26 (2.59) | 1.60 (1.91) | 1.59 (2.88) | 1.24 (2.73) | 1.76 a | 1.28 a |
| | 96-97 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 a | 0.00 a |
| | 97-98 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 a | 0.00 a |
| | 98-99 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 a | 0.00 a |
| | 99-00 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 a | 0.00 a |
| | 00-01 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.01 (0.00) | 0.01 (0.00) | 0.01 a | 0.01 a |
| | 01-02 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.01 (0.01) | 0.01 (0.01) | 0.00 a | 0.00 a |

a - software would not calculate a measure of dispersion for total

**Black Crappie**

Black crappies have not been a substantial component of the winter fishery at Waubay Lake. During the 2000-01 winter an estimated 537 black crappies were caught and 94 were caught during 2001-02 (Table 34). Prior to the 2000-01 winter black crappies had not been caught in measurable numbers during the winter months.

Table 36. Percentage of anglers harvesting a given number of yellow perch during a completed angling trip during winter periods (Dec 1998 - March 2002) at Waubay Lake, South Dakota. The number of completed trip interviews for each period are given.

| Number | 1998-99 | 1999-00 | 2000-01 | 2001-02 |
|---|---|---|---|---|
| 0 | 84.5 | 48.7 | 47.4 | 24.9 |
| 1 | 4.0 | 5.1 | 12.9 | 9.2 |
| 2 | 2.3 | 2.6 | 7.8 | 7.0 |
| 3 | 2.9 | 9.0 | 3.5 | 4.9 |
| 4 | 1.2 | 1.3 | 1.7 | 4.3 |
| 5 | 0.0 | 0.0 | 3.5 | 3.6 |
| 6 | 0.0 | 0.0 | 1.7 | 2.3 |
| 7 | 0.0 | 1.3 | 2.6 | 5.1 |
| 8 | 2.9 | 5.1 | 1.7 | 3.4 |
| 9 | 0.0 | 0.0 | 1.7 | 3.0 |
| 10 | 0.0 | 1.3 | 1.7 | 32.4 |
| 11 | 0.0 | 1.3 | 0.0 | |
| 12 | 0.0 | 2.6 | 0.9 | |
| 13 | 1.2 | 2.6 | 1.7 | |
| 14 | 0.0 | 1.3 | 0.0 | |
| 15 | 0.0 | 2.6 | 1.7 | |
| 16 | 0.0 | 0.0 | 0.0 | |
| 17 | 0.0 | 0.0 | 0.0 | |
| 18 | 0.0 | 2.6 | 0.9 | |
| 19 | 0.0 | 0.0 | 0.9 | |
| 20 | 0.0 | 0.0 | 0.9 | |
| 21 | 0.0 | 0.0 | 0.0 | |
| 22 | 0.0 | 0.0 | 0.0 | |
| 23 | 0.0 | 1.3 | 0.0 | |
| 24 | 0.0 | 1.3 | 0.9 | |
| 25 | 1.2 | 10.3 | 6.0 | |
| Total trips | 174 | 78 | 116 | 531 |

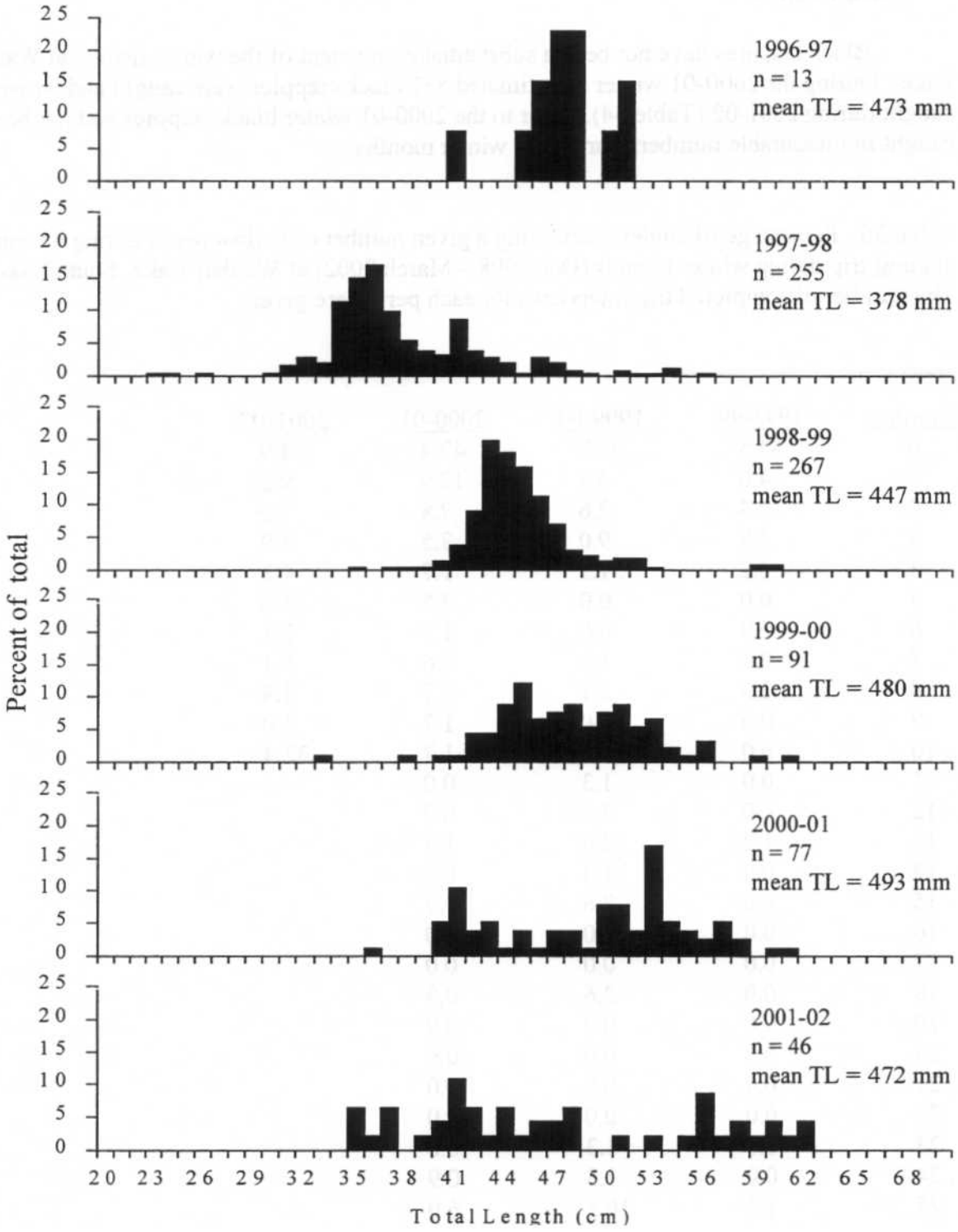


Figure 12. Length frequency histograms of angler harvested walleyes during winter periods of December 1996 through March 2002 for Waubay Lake, South Dakota, n is the number measured.

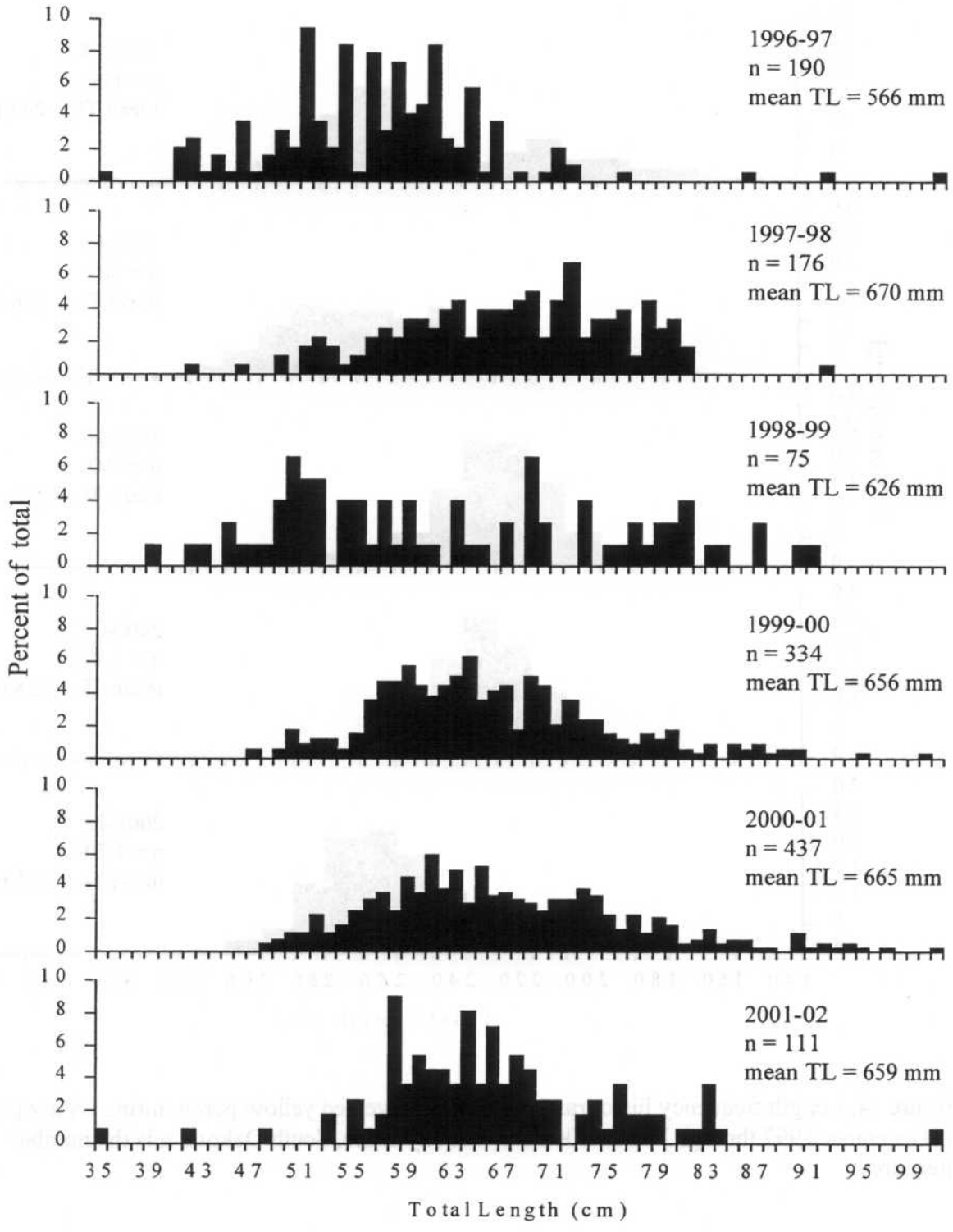


Figure 13. Length frequency histograms of angler harvested northern pike during winter periods of December 1996 through March 2002 for Waubay Lake, South Dakota, n is the number measured.

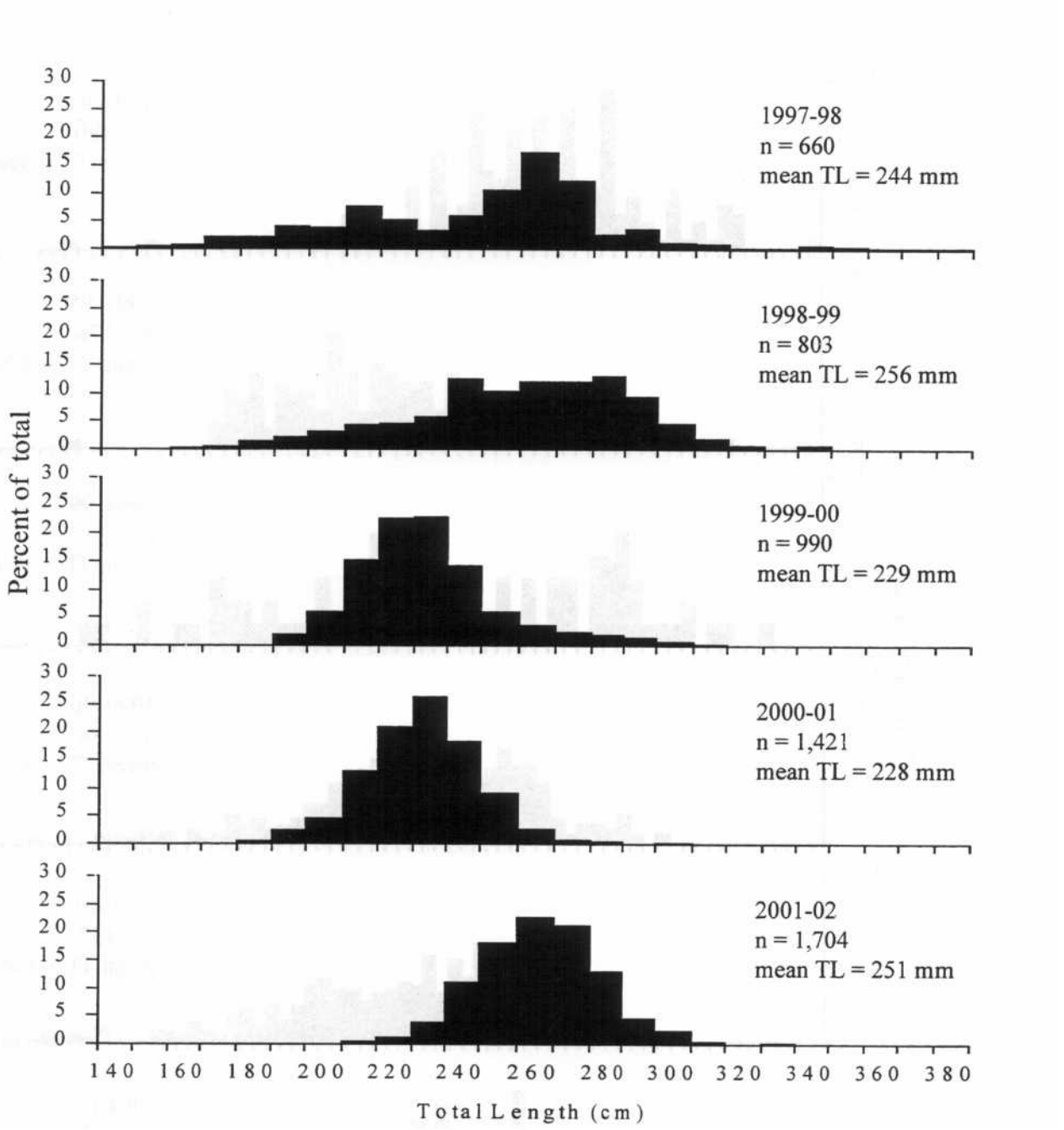


Figure 14. Length frequency histograms of angler harvested yellow perch during winter periods of December 1997 through March 2002 for Waubay Lake, South Dakota, n is the number measured.

Angler Demographics and Economic Impact

Similar to open-water surveys, resident anglers composed the majority of anglers between 1996 and 1999 (Table 37). During the three winter survey periods between December 1996 and March 1999, greater than 88% of anglers claimed South Dakota as their home residence. An increase in non-resident anglers was apparent in the last three winter surveys between December 1999 and March 2002 when the percent of resident anglers ranged from 62.6 to 77.6% (Table 37).

Day County and the immediate surrounding counties were the source of most resident anglers fishing Waubay Lake during the winter 1997-98 and composed a high percentage of the resident anglers in subsequent winter surveys (Figure 14). Aside for counties located in Northeast South Dakota, anglers from Brookings and Minnehaha counties have been frequent winter anglers.

Fourteen states in addition to South Dakota were represented during angler interviews (Table 38). Minnesota and Iowa were the most frequent nonresident winter angling visitors to Waubay Lake (Table 38). The combination of Minnesota and Iowa anglers typically exceeded 75% of the total nonresident anglers fishing Waubay Lake during the winter.

As the percentage of nonresident anglers increased and more South Dakota counties became represented in the Waubay Lake winter fishery a shift in the distance traveled could be observed across winter creel periods (Table 39). In the 1997-98 winter 44.8% of anglers traveled less than 25 miles, one way, to fish Waubay Lake, but in 2001-02 winter, only 16.4% traveled less than 25 miles. The greatest increase in traveled distance since the 1998-99 winter was in those anglers traveling greater than 100 miles. This increase corresponds with the increase in the percentage on nonresident anglers fishing Waubay Lake during the winter (Table 37).

The Waubay Lake winter fishery had an estimated economic impact of approximately $7 during the winters between December 1996 and March 2002 (Table 32). The winter of 1996-97 had the lowest economic gain primarily because the lake was in its infancy as a fishery and weather conditions made it difficult for anglers to gain access to the lake. The greatest economic impact was in 2002 when greater 2.2 million dollars were likely added to local economies.

Table 37. Monthly and overall percentage of open-water resident (SD) and nonresident (non) anglers fishing Waubay Lake, South Dakota from December through March (1996-2002).

| Year | | December | January | February | March | Overall |
|---|---|---|---|---|---|---|
| 1996-97 | SD | 100 | 100 | 92.6 | 93.7 | 95.3 |
| | non | 0.0 | 0.0 | 7.4 | 6.3 | 4.7 |
| 1997-98 | SD | 94.0 | 88.2 | 85.5 | | 88.1 |
| | non | 6.0 | 11.8 | 14.5 | | 11.9 |
| 1998-99 | SD | 93.1 | 92.7 | 86.3 | 83.1 | 88.7 |
| | non | 6.9 | 7.3 | 13.7 | 16.9 | 11.3 |
| 1999-00 | SD | 75.9 | 85.8 | 73.8 | 74.3 | 77.6 |
| | non | 24.1 | 14.2 | 26.2 | 25.7 | 22.4 |
| 2001-01 | SD | 72.6 | 72.3 | 50.8 | 84.7 | 62.6 |
| | non | 27.4 | 27.7 | 49.2 | 25.3 | 37.4 |
| 2001-02 | SD | 83.7 | 66.7 | 66.5 | 62.0 | 68.6 |
| | non | 16.3 | 33.3 | 33.5 | 38.0 | 31.4 |

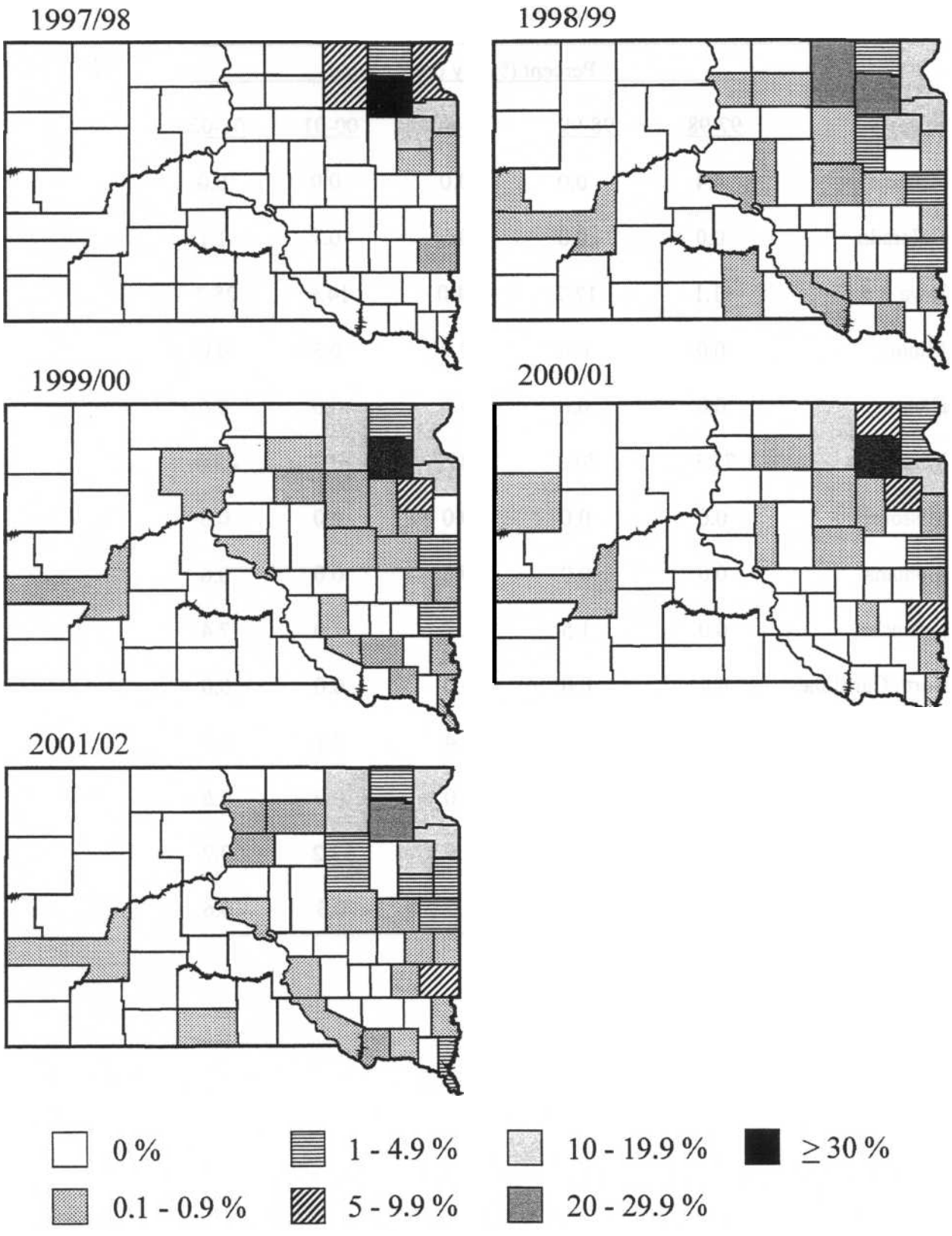


Figure 15. South Dakota county of residence for resident anglers fishing Waubay Lake, South Dakota during December 1997 through March 2002.

Table 38. Percent of non-resident anglers from various states that fished Waubay Lake, South Dakota during May through August of 1997 to 2002.

| | Percent (%) by creel period | | | | |
|---|---|---|---|---|---|
| State | 97-98 | 98-99 | 99-00 | 00-01 | 01-02 |
| Arizona | 4.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| Colorado | 0.0 | 0.0 | 0.0 | 0.7 | 1.1 |
| Iowa | 11.1 | 17.7 | 14.0 | 14.6 | 25.7 |
| Illinois | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 |
| Kansas | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| Minnesota | 73.3 | 70.8 | 71.5 | 61.7 | 48.0 |
| Missouri | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| Montana | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| Nebraska | 0.0 | 1.5 | 2.2 | 2.0 | 7.4 |
| North Carolina | 4.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| North Dakota | 6.7 | 10.0 | 8.4 | 7.1 | 4.0 |
| Tennessee | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| Wisconsin | 0.0 | 0.0 | 3.9 | 13.2 | 9.7 |
| Wyoming | 0.0 | 0.0 | 0.0 | 0.3 | 0.6 |

Table 39. Percent of anglers traveling the specified distances, one way, to fish Waubay Lake, South Dakota, during December through March (1997-2002).

| | Percent (%) by creel period | | | | |
|---|---|---|---|---|---|
| Distance | 97-98 | 98-99 | 99-00 | 00-01 | 01-02 |
| <25 | 44.8 | 25.3 | 26.0 | 25.8 | 16.4 |
| 25-50 | 30.9 | 29.1 | 26.4 | 16,5 | 22.6 |
| 51-100 | 17.3 | 31.4 | 25.0 | 19.7 | 25.7 |
| 101-200 | 3.5 | 9.6 | 12.2 | 15.1 | 17.4 |
| >200 | 3.5 | 4.6 | 10.5 | 23.0 | 17.9 |

Angler Opinions

A majority of winter anglers supported the walleye regulations during the 1998-99 and 1999-00 winters (Table 40). This is similar to the opinion provided by open-water anglers. During the same winter periods greater than 80% of the anglers were satisfied with their fishing trip (Table 41).

Anglers were asked to rate fish harvest as part of their angling success in 2000-01 and 2001-02. Surprisingly in 2001-02, 44.0% (Table 42) of interviewed anglers indicated that harvesting fish was not important, but yet during that same creel period the yellow perch harvest was the highest ever recorded for a winter survey (Table 34). In excess of 65% of anglers indicated that harvest was only somewhat or not important. Approximately 10% of anglers during both creel periods indicated that harvest was very important in their angling success.

In 2001-02, when asked what was an important factor in defining angling success, 18.8% of interviewed anglers said that harvesting fish the most important. Relaxation was the most frequent response when anglers were asked what was most important in defining a successful fishing trip (Table 43). Being able catch fish and harvest had similar frequencies.

In 2000-01, most (52.1%) of the interviewed anglers were against a reduction in the yellow perch daily limit (Table 44). During that same period only 6% of anglers harvested a 25-fish limit (Table 36). The most frequent response of anglers in favor of a reduction was a daily limit of 15 yellow perch followed by 20.

Table 40. Angler responses during December through March 1998-99 and 1999-01 to the question: "Are you supportive of the walleye harvest regulations for this lake?" n is the number of responses.

| | Percentage (%) | |
|---|---|---|
| Response | 1998-99 (n=1017) | 1999-01 (n=534) |
| Yes | 82.0 | 92.1 |
| No | 8.0 | 3.8 |
| No Opinion | 9.0 | 4.1 |

Table 41. Angler responses during December through March 1998-99 and 1999-01 to the question: "Considering all factors, how satisfied are you with your fishing trip today?" n is the number of responses.

| | Percentage (%) | |
|---|---|---|
| Response | 1998-99 (n=1,020) | 1999-01 (n=597) |
| Satisfied | 80.3 | 86.1 |
| Neutral | 3.9 | 2.0 |
| Dissatisfied | 15.8 | 11.9 |

Table 42. Angler responses during December through March 2000-01 and 2001-02 to the question: "How important would you rate harvesting fish in your angling satisfaction (i.e. do you need to harvest fish to have a successful fishing trip)?" n is the number of responses.

| | Percentage (%) | |
|---|---|---|
| Response | 2000-01 (n=447) | 2001-02 (n=525) |
| Not Important | 26.2 | 44.0 |
| Somewhat important | 39.1 | 29.3 |
| Important | 24.9 | 16.8 |
| Very Important | 9.7 | 9.9 |

Table 43. Angler responses during December through March 2001-02 to the question: "What is the most important factor to you in defining a successful fishing trip?" n is then number of responses.

| | Percentage (%) |
|---|---|
| Response | 2001-02 (n=517) |
| Relaxation | 45.5 |
| Harvesting fish | 18.8 |
| Participating | 7.1 |
| Catching fish | 21.5 |
| Being with friends | 7.1 |

Table 44. Angler responses during December through March 2000-01 to the question: "Would you be in favor of a reduction in the yellow perch daily limit?" Second part of question: "If yes, what do you think it should be?" n is the number of responses.

| | Percent (%) |
|---|---|
| Response | 2000-01 (n=447) |
| Yes | 34.2 |
| No | 52.1 |
| No Opinion | 13.6 |

| Number | Percent |
|---|---|
| 8 | 0.6 |
| 10 | 10.8 |
| 12 | 3.2 |
| 15 | 56.3 |
| 20 | 29.1 |

## Recommendations

1. Stock 9 million walleye fry in 2003. Mark a minimum of 6 million fry with oxytetracycline before stocking. Complete annual stocks until three year classes are established. Stocking rates will be based on previous fall electrofishing estimate of year class strength. Once three year classes are established, a dynamic stocking regime should be used.

2. Improve upon the walleye recruitment index using fall age-0 electrofishing results as an indicator of year class strength.

3. Continue to evaluate harvest regulations and inform/educate the public about regulations.

4. Continue to sample both the fish community and angler use. Long-term data sets are essential for interpreting fish community dynamics.

5. Age yellow perch and black crappie samples to gain increased insight into the dynamics of these species.

6. Develop sampling regime to evaluate the smallmouth bass population.

7. Determine causes and possible remedies to the absence of natural walleye recruitment.

8. Keep public informed on the Waubay Lake fishery status.

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Appendix 1. Common and scientific names of fishes mentioned in this report.

| Common name | Scientific name |
|---|---|
| Black bullhead | *Ameirus melas* |
| Black crappie | *Pomoxis nigromaculatus* |
| Common carp | *Cyprinus carpio* |
| Northern pike | *Esox lucius* |
| Lake herring | *Coregonus artedii* |
| Smallmouth bass | *Micropterus dolomieui* |
| Walleye | *Stizostedion vitreum* |
| White bass | *Morone chrysops* |
| White sucker | *Catostomus commersoni* |
| Yellow perch | *Perca flavescens* |